Ground-Water Data for the Riley and Andrews Resource Areas, Southeastern Oregon

U.S. GEOLOGICAL SURVEY
Open-File Report 80-419

Prepared in cooperation with the
U.S. BUREAU OF LAND MANAGEMENT

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1980

UNITED STATES DEPARTMENT OF THE INTERIOR
CECIL D. ANDRUS, Secretary
GEOLOGICAL SURVEY
H. William Menard, Director

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Contents

Illustrations

Tables

Conversion factors for inch-pound system and International System Units (SI)

[For use of those readers who may prefer to use metric units rather than inch-pound units, the conversion factors for the terms used in this report are listed below:]

Multiply inch-pound units	By	To obtain metric unit
	Length	
inch (in.)	25.40	millimeter (mm)
foot (ft)	0.3048	meter (m)
mile (mi)	1.609	kilometers (km)
	Area	
acres	.4047	hectares (ha)
square miles (mi^2)	2.590	square kilometers (km^2)
	Volume	
acre-feet (acre-ft)	1233	cubic meters (m^3)
acre-feet (acre-ft)	.001233	cubic hectometers (hm^3)
cubic feet (ft^3)	.02832	cubic meters (m^3)
gallons (gal)	3.785	liters (L)
Mgal (million gallons)	3785	cubic meters (m^3)
	Specific combinations	
cubic feet per second (ft^3/s)	.02832	cubic meters per second (m^3/s)
gallons per minute (gal/min)	.06309	liters per second (L/s)
gallons per minute per foot [(gal/min)/ft]	.2070	liters per second per meter [(L/s)/m]
million gallons per day (Mgal/d)	3785	cubic meters per day (m^3/d)
	Temperature	
degrees Fahrenheit (°F)	5/9 after subtracting 32 from F° value	degrees Celsius (°C)

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INTRODUCTION

Appraisals of the resources of selected management areas in eastern Oregon are being made by the U.S. Bureau of Land Management. To provide needed hydrologic information, the Bureau of Land Management requested the U.S. Geological Survey to inventory ground-water data for the Riley and Andrews Resource Areas. The inventory included field location of selected wells and springs; measurement of ground-water levels, temperatures, specific conductance, and pH; and the collection of ground-water samples from selected sources to determine dissolved chemical constituents.

Included in this report are well data, drillers' lithologic logs, hydrographs of observation wells, a summary of observation-well data, and chemical analyses of ground water.

Previous Investigations

The ground-water resources in parts of the study area have been discussed in previous reports, the oldest being Waring's (1909), which covers most of the area. The report by Piper and others (1939) covers the eastern half of the area southward to Frenchglen. Leonard' report (1970) describes the occurrence, distribution, availability, and chemical quality of ground water in Harney Valley. The Harney Valley report (Leonard, 1970) could serve as a basis for interpretation and evaluation of data for similar playa areas. The report by Hubbard (1975) describes surface-water inflows to Malheur Lake and includes a detailed water budget.

Geologic information for the resource areas is included in the reports by Waring (1909), Piper and others (1939), and Leonard (1970). Available geologic maps at scales of 1:250,000 and 1:500,000 include "Geologic Map of the Burns Quadrangle, Oregon" (Greene and others, 1972); "Reconnaissance Geologic Map of the Adel Quadrangle, Lake, Harney, and Malheur Counties, Oregon" (Walker and Repenning, 1965); and "Geologic Map of Oregon East of the 121st Meridian" (Walker, 1977). Williams and Compton (1953) describe the geology and mineral deposits in the Pueblo Mountains and southern part of Steens Mountain. Several agencies have ongoing studies of the geothermal resources of Harney County, and results of those studies provide additional data, such as the chemical analyses of hot springs included in table 4.

Water levels in representative observations wells in Oregon are measured periodically by the Oregon Water Resources Department (formerly the Oregon State Engineer), and water-level reports are published by that agency (Bartholomew and others, 1973).

Location and Description of the Area

The Riley and Andrews Resource Areas include most of Harney County in eastern Oregon (fig. 1). Small segments extend into Lake and Malheur Counties and into Humboldt County, Nev. Boundaries of the resource areas were established by the Bureau of Land Management to define land units that are managed by the Bureau's Burns District. Land in the Riley and Andrews Resource Areas is in both private and public ownership, but the major part is held in public trust by the Bureau of Land Management. The total area included in the two resource areas exceeds 6,100 mi^2.

The only incorporated cities in the study area are Burns and Hines, Oreg., near the northeastern edge of the Riley Resource Area. The estimated combined population of the two cities was 5,170 in 1976 (Oregon Secretary of State, 1977). The population density of the two resource areas is greatest in the Harney Valley near Burns and Hines; elsewhere it is extremely light. Small unincorporated settlements include Riley, Wagontire, Frenchglen, Andrews, and Fields, all in Oregon. Denio is adjacent to the State boundary in Nevada.

Good highways cross part of the study area, but much of the area is accessible only during summer and fall by using four-wheel-drive vehicles.

The Riley Resource Area includes the western two-thirds of Harney Basin, the closed basin that drains toward Malheur and Harney Lakes. That basin includes the flat, featureless plain of Harney Valley; a similar small plain around Harney Lake; and uplands that border those valleys. Harney Valley slopes from about 4,150 ft near Burns to 4,090 ft at Malheur Lake, and the plain around Harney Lake is a few feet lower. The Andrews Resource Area includes Steens Mountain, which attains an altitude of more than 9,000 ft and is the highest of the uplands. Also included are Catlow and Alvord Valleys, and parts of the Pueblo and Trout Creek Mountains. The lowest part of the Catlow Valley closed basin is about 4,500 ft, and the lowest part of Alvord Valley is about 4,000 ft.

Harney Basin and Catlow and Alvord Valleys are closed basins with only internal drainage. The principal streams in the Harney Basin are the Silvies River and Silver Creek, which flow southward and drain the upland in the northern part of the Riley Resource Area, and the Donner und Blitzen River which drains the western ramplike slope of Steens Mountain and flows northward into Malheur Lake. The largest stream in the Andrews Resource Area is Trout Creek, which flows north through Pueblo Valley into Alvord Lake, an alkali lake in Alvord Valley. In addition, numerous small streams flow off the east flank of Steens Mountain into Alvord Valley, and a few small streams flow into Catlow Valley.

General Geology

The uplands along the borders of Harney Basin are formed by volcanic and pyroclastic rocks and nonmarine sediments derived from volcanic rocks. Lava flows of varying composition include basalt, andesite, rhyolite, and dacite. The rhyolite and rhyodacite commonly are porphyritic or contain spherulites and opaline lithophysae. Obsidian occurs locally. The pyroclastics include tuff, breccia, welded tuff, pumice, cinders, and lapilli. Silt and clay predominate among the sediments, but sandstone, conglomerate, fanglomerate, diatomite, and unconsolidated sand and gravel occur locally. In many places, the sediments are interbedded with lava flows or pyroclastics.

The uplands are cut by numerous faults, and the rock strata slope gently toward Harney Falley, which is both an erosional and a structural basin (Leonard, 1970, p 11).

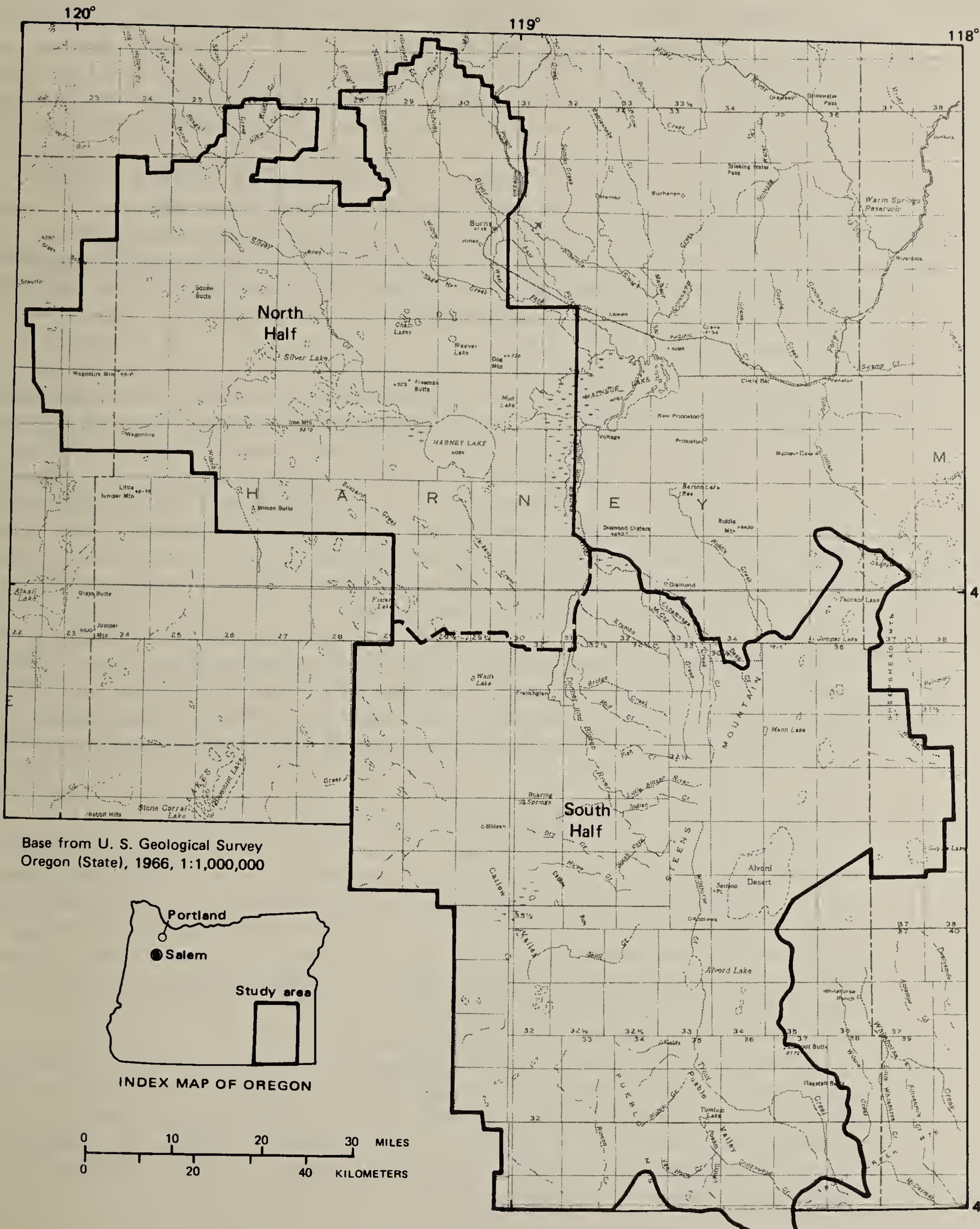

Figure 1.—Map showing the location and general features of the Riley and Andrews Resource Areas.

Unconsolidated valley-fill deposits underlie the Harney Valley floor to a maximum of about 250 ft (Leonard, 1970; Piper and others, 1939). The valley-fill deposits consist chiefly of silt and clay, but contain lenticular deposits of sand and gravel in alluvial fans and also along buried stream courses. Beneath the valley-fill deposits is a large but unknown thickness of consolidated rocks similar in composition to those exposed in the bordering uplands.

Farther south, faulting of the uplands has produced the Steens and Pueblo Mountains. These volcanic rocks have been tilted gently toward the west by a major set of faults (Williams and Compton, 1963, p. 32; Lund and Bentley, 1976, p. 51–53); consequently, most of the upland drains westward to the Donner und Blitzen River or into Catlow Valley. Catlow, Alvord, and Pueblo Valleys are underlain by an undetermined thickness of valley-fill deposits derived from these uplands.

Occurrence of Ground Water

Large quantities of ground water are withdrawn by numerous wells from sand and gravel and from consolidated rock aquifers near Burns, in Silver Creek and Catlow Valleys, and along the western margins of Alvord and Pueblo Valleys. Many wells produce as much as several hundred gallons of water per minute, and the water is used chiefly for irrigation. The distribution of the consolidated rock aquifers beneath the valley-fill deposits is generally poorly known, especially in Catlow and Alvord Valleys. Ground water in Harney Valley is generally confined beneath beds of clay or other rocks of low hydraulic conductivity (Piper and others, 1939). Locally, ground water in shallow sand and gravel aquifers is unconfined.

A large part of the study area is upland in which ground-water recharge is chiefly by direct infiltration of precipitation, and by local infiltration along streams during periods of high runoff. Each spring, snowmelt runoff from upland streams floods large areas of the Harney Valley floor and recharges the shallow section of the valley fill (Leonard, 1970). Upward movement of ground water from the underlying consolidated rocks also provides small quantities of recharge to the valley-fill deposits (Piper and others, 1939, p. 70). Similarly, Catlow, Alvord, and Pueblo Valleys receive the runoff from the Steens, Pueblo, and Trout Creek Mountains.

The general direction of movement of ground water in the Riley and Andrews Resource Areas is from upland recharge areas toward valley areas where the ground water is discharged from springs, by diffuse seepage to streams, by evapotranspiration, or by wells. In Harney Basin, ground water in the valley-fill deposits is moving toward Malheur and Harney Lakes. In Catlow, Pueblo, and Alvord Valleys, ground-water discharge from springs in common along the bases of alluvial fans. Evapotranspiration of shallow ground water probably is the cause of large areas of alkali soils in the valleys (U. S. Salinity Laboratory Staff, 1954).

Locally in these valleys, wells and springs yield warm, geothermally heated ground water; many of these sources are described by Piper, Robinson, and Park (1939) and Waring (1965). Chemical analyses of water from geothermal springs have been reported by Mariner and others (1975). Data for a few selected hot springs are listed in the accompanying tables; other data are available from files of the U.S. Geological Survey and Oregon Department of Geology and Mineral Industries.

EXPLANATION OF DATA

Well- and Spring-Numbering System

Wells and springs are assigned a number based on their location according to the rectangular system for subdivision of public lands. In successive order, the numerals represent the township, range, and section. Thus, well 36S/33E-16dcb is in township 36 south, range 33 east, section 16. A graphic illustration of this method of well location is shown in figure 2. The letters following the section number show the location in the section, the first letter designating the quarter section (160 acres), the second letter the quarter-quarter section (40 acres), and the third letter the quarter-quarter-quarter section (10 acres). Where two or more wells are in the same 10-acre subdivision, serial numbers are added after the third letter. For a spring, a lower case "s" follows the third letter.

Records of Wells and Springs

Records of wells and springs in the Riley and Andrews Resource Areas are listed in table 1, following the text. Some well records have been published for the Harney Valley area (Leonard, 1970; Gonthier and others, 1977). The wells in table 1, many of which have drillers' logs available, have been field located, and their locations are shown on plate 1. Well and spring locations were plotted on 1:63,360-scale Bureau of Land Management planimetric maps and Geological Survey 1:24,000 topographic maps. Table 1 also includes some data on selected springs, including an estimate of the discharge of the spring at the time of the visit. Little or no data were available, however, for estimating fluctuations in the discharge of those springs.

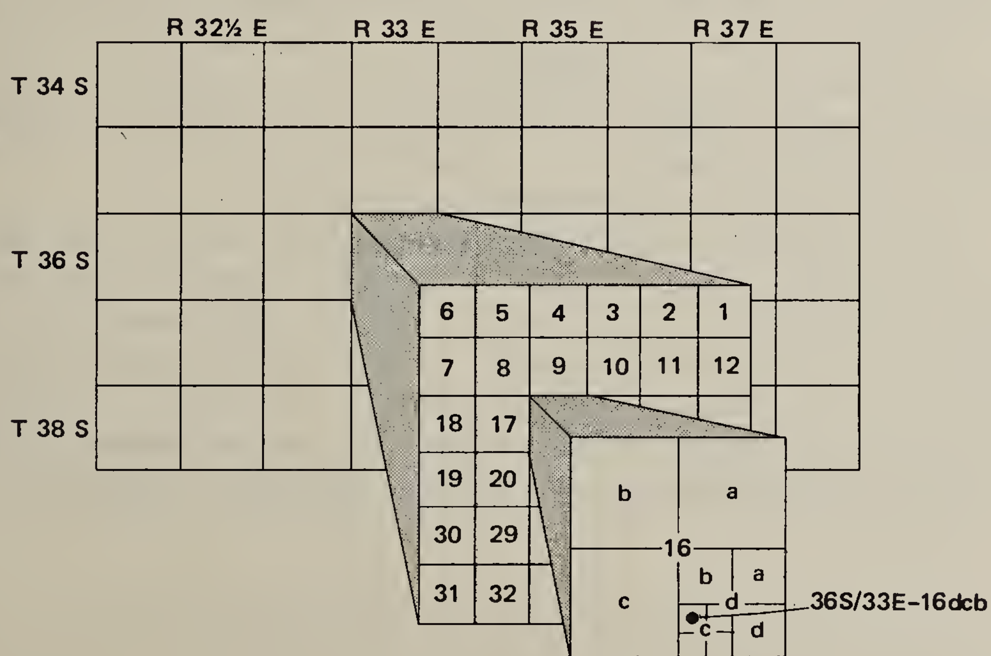

Figure 2.—Well and spring numbering system.

Drillers' Logs of Wells

Drillers' logs of wells are obtained from reports that have been submitted by drillers to the Oregon Water Resources Department since 1956, from Geological Survey files, and from records supplied by the Bureau of Land Management. Drillers' terminology for the materials penetrated, which varies from driller to driller, is used in table 2. The logs have been edited so that lithology is given first.

Hydrographs of Observation Wells

Date for observation wells in the study area are summarized in table 3, and are shown in figure 3 hydrographs of ground-water levels in 10 representative observation wells of 22S/31E–34ccb and 23S/31E–16dbb. Records for most of the wells started between 1962 and 1969, but measurements started in 1930. Ground-water levels generally rise each year when the ground-water reservoir is recharged and storage increases. If, over a period of time, ground-water discharge exceeds the rate of recharge, water levels gradually decline, and the hydrographs show a declining trend. Conversely, a rising trend occurs when ground-water recharge exceeds ground-water discharge. Seasonal variations range from less than a foot in well 25S/31E–29acb to more than 10 ft for several wells. In most of the study area, neither rising nor declining long-term trends are apparent, and the ground-water levels are more or less stable.

Chemical Quality of Ground Water

Ground-water samples from 25 wells and springs in the Riley and Andrews Resources Areas of Harney County were collected by the Geological Survey in 1979 for chemical analysis (table 4). In addition where possible, the specific conductance of water was measured, for each well and spring visited in 1979 and those measurements are reported in table 1. Table 4 also includes several analyses of water samples analyzed earlier from Harney Valley and several analyses of thermal springs from the Survey's geothermal file.

Analyses of samples from four wells (23S/23E–27acb, 26S/31E–33ccc, 29S/37E–17cca, 40S/36E–19ddd) and two springs (32S/36E–29daas and 37S/32½E–7dads) were made by the plasma-scan method. Determinations by that method are less precise than analyses by more "standard" methods; therefore, most of the constituents are reported to only one significant figure in table 4. In addition to the constituents reported in table 4, the plasma-scan analyses included a semiquantitative determination of more than 20 metals and trace elements which are tabulated in table 5.

The specific conductance of a water sample measures the ability of water to conduct an electrical current and is related to the concentration of the ionized dissolved constituents. Specific-conductance calues in table 4 range from 56 to 4,590 micromhos per centimeter at 25°C, sulfate from 2.1 to 328 mg/L, fluoride from 0.1 to 19.0 mg/L, and arsenic from less than the detection limit to 1.0 mg/L. The highest measured values for all chemical constituents were in water from thermal springs. The source and significance of the chemical constituents and physical properties are summarized in table 6.

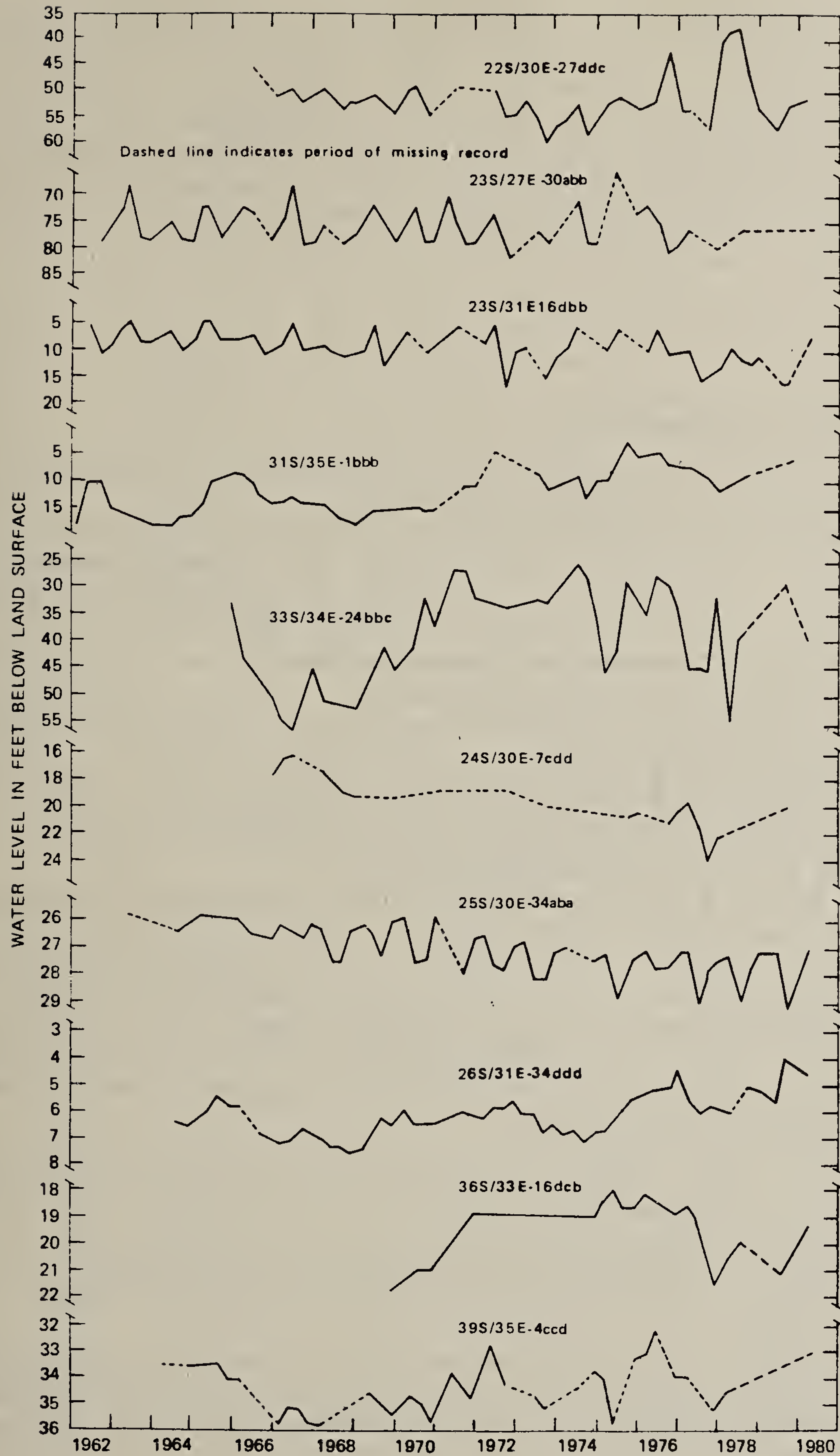

Figure 3.—Hydrographs of selected observation wells.

Thermal water has been defined as being at least 15°F (9°C) above the mean annual air temperature at the site (Waring, 1965), therefore 65°F or higher for the study area. Thermal water occurs in wells and springs in several parts of the Riley and Andrews Resource Areas, notably near Hines, around Harney Lake, and in Alvord Valley.

Temperatures above 100°F (38°C) were noted for five springs and one well reported in table 1. These waters have many similarities, including the concentrations of dissolved solids, silica, sodium, chloride, fluoride, and boron (table 4).

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Table 1.--Records of selected wells and springs

Well or spring number: See page for description of well- and spring-numbering system.
Depth of casing: Depth of casing indicates total length of casing.
Finish: P, perforated; X, open hole; O, open end.
Character of material: Character of material refers to water-bearing formations as reported by driller.
Altitude: Altitude of land surface at well, in feet above mean sea level, interpolated from topographic maps.
Water level: Depths to water below land surface given in feet and decimals were measured by personnel of the Geological Survey; those given in whole feet were reported by well driller or owner. F, flowing well whose static water level is not known.
Use: H, domestic; I, irrigation; P, public supply; S, stock; U, unused.
Remarks: Ca, chemical analysis reported in table ; L, driller's log in table . B, bailed, P, pumped for indicated time to determine yield under "Well performance." Obs, observation well whose water level is measured periodically. Well and spring numbers are Burns District, Bureau of Land Management, identification numbers.

Well or spring number	Owner	Year completed	Depth of well (feet)	Diameter of well (inches)	Depth of casing (feet)	Finish	Character of material	Altitude (feet)	Feet below datum	Date	Specific conductance of water	Temperature (°C)	Temperature (°F)	Well performance: Yield (gal/min)	Well performance: Drawdown (feet)	Use	pH	Remarks
T. 20 S., R. 30 E.																		
18bda	Robert Smith	1978	95	8	19	X	Clay	4,280	20	8-11-78	--	--	--	7	0	U	--	L, B 1 hr, no pump.
21bcds	do	--	--	--	--	--	--	4,280	--	--	165	15	60	--	--	S	7.3	Undeveloped.
T. 22 S., R. 26 E.																		
30dbd	Carl Mayo	1968	98	10	60	P, 36-60, X, 60-90	Gravel	--	6.8	6-28-79	126	26	79	100	--	S	--	L, B 1½ hr.
T. 22 S., R. 30 E.																		
27ddc	W. W. Arntz	1961	127	12 3/4	40	X	Clay, lava, and boulders	4,230	38.06	7- 5-78	140	14.0	57	700	--	I	--	L, Obs; Ca.
T. 22 S., R. 31 E.																		
28abb	Jack Drinkwater	1970	215	6	30	X	Pumice	4,285	150.8	8- 9-79	230	15	60	15	5	S	7.4	L, P 2 hr, Ca.
28dda	Harry Pon	1961	490	12	22	X	Sand and clay	4,170	20.77	3- 2-78	--	11.0	52	1,000	42	I	--	L, P 4 hr, Obs.
34ccb	Jay Hoyt	1930	288	18	68	X	--	4,154	15.05	5-24-78	--	--	--	400	50	S	--	Obs.
T. 23 S., R. 23 E.																		
27acb	U.S. Bureau of Land Management	--	507.5	6	32	X	--	--	465.5	7- 6-79	530	27	81	6.6	6	S	6.1	Ca, Glass Butte well No. 37.
T. 23 S., R. 25 E.																		
31cab	U.S. Bureau of Land Management	1955	393.5	6	--	--	--	--	312.5	4-28-77	390	13.6	56	18	--	S	7.2	Gap Ranch well No. 35.
T. 23 S., R. 26 E.																		
5bab	George McGee	1973	133	8	32	X	Clay	--	120.4	6-28-79	140	12.5	54	20	--	S	6.3	L, B 3 hr, Ca.
23ddd	do	1968	80	10	20	X	Sand	--	104.6	6-29-79	190	12.3	54	25	30	S	7.0	L, B 1 hr; apparently deepened.
28cba	U.S. Bureau of Land Management	1973	198	6	192.4	X	Gravel	4,400	165	6-22-73	--	--	--	10	--	P	--	L, P 4 hr, Chickahominy well No. 53.

Table 1.--Records of selected wells and springs--Continued

Well or spring number	Owner	Year com-pleted	Depth of well (feet)	Diameter of well (inches)	Depth of casing (feet)	Finish	Character of material	Alti-tude (feet)	Water level: Feet below datum	Water level: Date	Specific conduct-ance of water	Temper-ature (°C)	Temper-ature (°F)	Well performance: Yield (gal/min)	Well performance: Draw-down (feet)	Use	pH	Remarks
							T. 23 S., R. 27 E.											
7caa	Gene Clark	1978	407	16	192	P, 170-192, X, 192-407	Cinders and gravel	--	103.7	6-28-79	--	--	--	20	--	I	--	L, B 1 hr.
19cdd	do	1977	525	16	20	X	Sandstone and gravel	--	83.1	do	--	--	--	20	--	I	--	Do.
27bac	Hoover Cattle Co.	1968	180	10	105	X	Clay and sand	--	40	8-21-68	160	22	72	40	--	I	7.8	Do.
30abb	Green Valley Ranch	1962	268	24	42	X	Gravel(?)	--	75.77	5-25-78	--	--	--	--	--	I	--	Obs.
							T. 23 S., R. 28 E.											
11caas	U.S. Bureau of Land Management	--	--	--	--	--	--	--	--	--	82	15.1	59	1	--	S	--	Elliot Spring No. 17.
27abb	do	1955	441	6	--	--	--	4,612	435.9	7-17-79	110	16	61	--	--	S	6.9	Elliot well No. 38.
35dad	Oregon State Highway Dept.	1969	497	6	497	P, 397-497	Sand and gravel	--	398	2-21-69	230	15.4	60	52	5	I,P	8.0	L, P 3 hr.
							T. 23 S., R. 29 E.											
11bba	U.S. Bureau of Land Management	--	300	--	--	--	--	4,630	--	--	--	--	--	--	--	U	--	Oil/water well No. 75.
							T. 23 S., R. 30 E.											
36bbc	Walter Baker	1930?	--	12	--	--	--	4,137	2.72	3- 2-78	--	--	--	1,100	--	I	--	P, Obs.
							T. 23 S., R. 31 E.											
5aac	Harry Pon	1961	400	12	95	P, 18-34, 52-26, 69-74, 93-95, X 95-400	Sand and gravel	4,157	19.81	5-25-78	240	16.5	62	1,000	22	I	--	Harry Pon well 15a, Obs, L, P 4 hr, Ca.
16bcc	Harney County	1936	14	18	14	P, 0-14	Sand	4,146	5.43	3-24-71	--	--	--	--	--	U	--	Obs.
16dbb	L. H. Hill	1930	300	12	37	P, 0-37, X, 37-300	Gravel and sand	4,146	11.03	7- 5-78	--	15.0	59	750	26	I	-- --	Piper well No. 65, L, P, Obs.
33cbc	Harney County	1935	13	18	11	X	Sand	4,134	7.34	11-18-70	--	--	--	--	--	U	--	L, Obs.
							T. 24 S., R. 23 E.											
9ddb	U.S. Bureau of Land Management	1958	477	6	--	P	Sand and gravel	--	439.4	7-16-79	170	22.5	72	10	1	S	7.1	L, B, Bush Well No. 62.
							T. 24 S., R. 25 E.											
15cbb	Squaw Butte Experiment Station	--	670	6	--	--	Sand and volcanic rock	4,863	550	7-20-67	280	23.6	74	--	--	H	8.0	L, deepened section.
							T. 24 S., R. 26 E.											
3bbb	U.S. Bureau of Land Management	1957	242	6	247	P, 200-238	Sandstone	--	167.3	6-29-79	260	16.5	62	20	--	S	7.8	L, B, Juniper Ridge well No. 36.

Table 1.--Records of selected wells and springs--Continued

Well or spring number	Owner	Year com-pleted	Depth of well (feet)	Diameter of well (inches)	Depth of casing (feet)	Finish	Character of material	Alti-tude (feet)	Water level: Feet below datum	Water level: Date	Specific conduct-ance of water	Temper-ature (°C)	Temper-ature (°F)	Well performance: Yield (gal/min)	Well performance: Draw-down (feet)	Use	pH	Remarks
T. 24 S., R. 26 E.--Continued																		
19abb	U.S. Bureau of Land Management	1954	422	6	--	--	--	--	5.7	6-29-79	--	--	--	--	--	U	--	Piersol well No. 34. No power to pump.
T. 24 S., R. 27 E.																		
10acc	Silver Creek Ranch	1978	408	18	38	X	Clay and sandstone	--	40.3	7- 5-79	206	11.4	53	100	10	I	7.6	L, B 1 hr, Ca.
11bab	do.	1968	400	16	32	X	Sand and gravel	--	39.96	11-17-77	--	--		2,850	161	I	--	P 8 hr, Obs.
T. 24 S., R. 30 E.																		
1abd	O. D. Hotchkiss	1930	564	10	117	X	Sandstone and vol-canic rock	4,134	F	9-11-68	194	27	80	600	--	I	--	L, Ca. Deepened in 1964 from 472 ft.
7cdd	Adolf Kisle	1962	347	14	347	P, 100-342,	Gravel and cinders	4,155	8	8- 6-62	160	11.0	52	1,800	84	I	--	L, P 3 hr, Obs.
26ddc	John Campbell	1959	501	16	150	P, 90-95, 110-115, 130-135, X, 150-501	Boulders, sand and clay	4,136	50.7	10-11-68	380	12.0	54	2,500	16	I	--	L, P 4 hr, Obs.
T. 24 S., R. 31 E.																		
28bcc	Harney County	1936	19	18	15	X	Fine sand, gravel, and clay	4,126	7.2	12- 3-70	--	--	--	--	--	U	--	L, Obs.
T. 25 S., R. 23 E.																		
31bba	U.S. Bureau of Land Management	--	541	--		--	--	4,830		--	--	--	--	--	--	S	--	Sand Hollow well No. 65. No power to pump.
T. 25 S., R. 28 E.																		
25dbb	Don Miller	1957	112	8	44	X	"Boulders" and gravel	--	15	8-14-57	1,005	12.8	55	36	20	H	7.5	L, B.
T. 25 S., R. 29 E.																		
29caa	Hurlburt Ranches, Inc.	1978	457	16	200	P, 69-80, 100-120, X, 200-457	Coarse sand and fine gravel	--	24.36	7- 5-79	550	11.4	53	700	35	I	7.7	L, P 7 hr, Ca.
T. 25 S., R. 30 E.																		
27cca	H. K. Tavermer	1952	78	--	--	--	--	4,130	37.93	7- 3-79	230	10.6	51	--	--	I	7.7	
34aba	Forrest Reed	1963	97	22	97	P, 60-80	Cinders and sand	--	29.02	7- 5-78	--	--	--	600	67	I	--	Obs.
T. 25 S., R. 31 E.																		
4cba	James Stahl	1962	170	12	90	X	Sand and gravel	4,140	35.18	12- 3-70	--	12.0	54	100	86	U	--	L, P 3½ hr, Obs.
29ccb	Edgar Koeneman	1963	209	8	104	P, 70-80, X, 104-209	Gravel	4,170	70.56	do.	--	13.5	56	100	70	U	--	L, P 4 hr, Obs.
T. 25 S., R. 32 E.																		
7bab	Island Ranch	1952	1,345	6	--	--	Clay and sand	4,106	F	5-27-69	1,450	40.5	105	3	--	S	--	Ca.

Table 1.--Records of selected wells and springs--Continued

Well or spring number	Owner	Year com-pleted	Depth of well (feet)	Diameter of well (inches)	Depth of casing (feet)	Finish	Character of material	Alti-tude (feet)	Water level: Feet below datum	Water level: Date	Specific conduct-ance of water	Temper-ature (°C)	Temper-ature (°F)	Well performance: Yield (gal/min)	Well performance: Draw-down (feet)	Use	pH	Remarks
							T. 26 S., R. 22 E.											
23bac	Carlon Bros.?	1944	353.5	6	--	--	Basalt	4,600	320	10- 9-48	--	--	--	--	--	S	--	Edes well.
							T. 26 S., R. 26 E.											
13cdd	U.S. Bureau of Land Management	1957	153	6	121	P, 103-118, X, 121-153	Sand, gravel, and clay	--	73.74	7- 2-79	--	--	--	10	14	U	--	L, B, no pump. Big Stick Reseeding well No. 57.
							T. 26 S., R. 29 E.											
1bcc	--	--	--	--	--	--	--	4,121	--	--	890	12.4	54	--	--	S	--	
18aac	Hurlburt Ranches, Inc.	1957	104	6	54	X	Sand, gravel, and cinders	--	4.56	7- 4-79	2,410	12.3	54	35	6	S	8.2	L, B.
							T. 26 S., R. 30 E.											
18dad	Mike Stafford	1975	430	12	200	X	Sand, clay, gravel, and pumice	4,110	15.5	7-17-79	--	--	--	635	104	U	--	L, P 3 hr, no pump.
							T. 26 S., R. 31 E.											
10dca	William Cherry, Jr.	1970	365	6	348	X	Clay, sand, and coarse gravel	4,095	3.87	7-18-79	--	--	--	150	39	U	--	L, P 4 hr, abandoned.
18dbc	M. Davis	1967	335	6	175	X	Sand and lava	4,113	20.2	7- 3-79	100	18.5	65	20	8	H	8.2	L, B 2 hr.
26bba	Harney County Land Development Corp.	1962	230	6	230	P, 90-225	Sand and gravel	4,105	13.25	11-20-67	--	--	--	100	4	H	--	L, P 4 hr, Obs.
33ccc	Larry Dunn	1960	525	12	70	X	Shale and sandstone	4,110	F	7-19-79	1,130	25	77	600	--	I	9.5	L, Ca. Flowing from pipe 3 ft above surface.
33dba*	Rex Taylor	1962	328	14	328	P, 90-318	Lava and gravel	4,099	2.1	7-19-79	--	--	--	1,500	90	I	--	L, P 3 hr.
34ddd*	M. J. Haines	1959	147	12	91	X	Cinders	4,099	2.90	7- 5-78	--	--	--	900	11	I	--	P 6 hr, Obs.
							T. 27 S., R. 23 E.											
8ccc	Doug Tracy	1948	129	6	--	--	Basalt	--	115.56	10- 9-48	450	17	63	30±	--	S	7.5	
							T. 27 S., R. 24 E.											
5ccd	Tom Atwell	1920	490	4	6-10	--	--	4,727	443	7-20-55	140	17	63	3-4	--	H	7.4	Deepened in 1954.
							T. 27 S., R. 25 E.											
16ccd	John Peila	1969	380	6	61	X	Lava	--	369	3-20-69	--	--	--	8	--	U	--	L, B 3 hr, abandoned.
							T. 27 S., R. 29 E.											
3ccc	Hurlburt Ranches, Inc.	1931	60	--	--	--	Fine gravel	4,101	F	7-28-31	420	11	52	5.5	--	H	7.8	L. Flowing 4+ ft above surface.
9caa	Vergil Moon	1967	200	12	65	P, 20-30, 35-40, 52-63, X, 65-200	Broken rock	--	20	5- 6-67	350	19	66	100	5	I	7.5	L, B 5 hr, deepened.

* South of Malheur Lake.

Table 1.--Records of selected wells and springs--Continued

Well or spring number	Owner	Year completed	Depth of well (feet)	Diameter of well (inches)	Depth of casing (feet)	Finish	Character of material	Altitude (feet)	Water level: Feet below datum	Water level: Date	Specific conductance of water	Temperature (°C)	Temperature (°F)	Well performance: Yield (gal/min)	Well performance: Drawdown (feet)	Use	pH	Remarks
T. 27 S., R. 29½ E.																		
36ddas	U.S. Bureau of Land Management	--	--	--	--	--	--	--	--	--	2,970	68.0	154	150	--	U	7.3	Near Harney Lake, Ca.
T. 27 S., R. 30 E.																		
14bbb	U.S. Bureau of Land Management	1976	341	6	341	P, 141-321	Gravel	--	142	5-15-76	650	20	68	35	118	S	7.6	P 8 hr, Ca. North Eagles Nest well No. 69.
34bab	do	1976	356	6	356	P, 196-316	"Metamorphic" gravel	--	138	5- 1-76	--	--	--	65	20	S	--	L, P 6 hr. South Eagles Nest well No. 70.
T. 27 S., R. 31 E.																		
9bba	Malheur Field Station	1965	500	12	166	P, 136-166, X, 166-500	Clay, gravel, and boulders	4,115	18.15	7-17-79	2,400	15.5	60	5	80	H	7.8	L, B 1 hr.
T. 28 S., R. 30 E.																		
24add	George Hamilton	1965	520	6	190	P, 45-60, X, 190-520	Clay and coarse sand	--	170	3-15-65	--	--	--	10	170	S	--	L, P 3 hr, deepened, no power to pump.
T. 29 S., R. 32 E.																		
27bdb	Harney County	1957	430	6	--	X	--	4,270	130	12-21-57	390	20.0	68	60	10	H	7.1	L (incomplete), P 2 hr.
32cba	Marvin Morger	1959	71	6	38	X	Cinders and gravel	4,180	35	9-18-59	--	--	--	10	35	H	--	P 3 hr.
35cac	U.S. Bureau of Land Management	1962	325	6	--	--	Sandstone	4,433	272.2	6-31-77	225	18.8	66	6	--	S	7.4	B, Ca. Witzel well.
T. 29 S., R. 37 E.																		
17cca	Fred Pallock	--	190	--	--	--	--	4,061	100.92	8- 7-79	420	13	55	--	--	S	7.3	Ca, Obs.
T. 30 S., R. 31 E.																		
10cdb	Fred Witzel	1963	240	6	100	X	Sandstone and gravel	4,155	9.4	7-20-79	--	--	--	70	4.5	U	--	L, P 16 hr, abandoned.
36dad	U.S. Bureau of Land Management	1979	560	6	300	P, 260-300, X, 300-560	Mudstone	4,410	260	6-15-79	--	--	--	3	--	S	--	L, At 2 hr, no pump. Witzel well No. 20.
T. 30 S., R. 32 E.																		
1dcc	U.S. Bureau of Land Management	1959	370	6	5	X	Clay and gravel	4,498	295	3- -69	440	14.5	58	20	--	S	7.5	L, B. Cucamunga well No. 13.
8cad	do	--	427	6	--	--	--	4,445	244.5	7-19-79	180	19	66	--	--	H	7.3	Hog Wallow well No. 12.
11baa	do	1971	410	6	211	X	Claystone	4,514	167?	7-20-79	240	19	66	20	9	S	7.5	L, P 2 hr. Ruby Springs well No. 11.

Table 1.--Records of selected wells and springs--Continued

Well or spring number	Owner	Year completed	Depth of well (feet)	Diameter of well (inches)	Depth of casing (feet)	Finish	Character of material	Altitude (feet)	Water level: Feet below datum	Water level: Date	Specific conductance of water	Temperature (°C)	Temperature (°F)	Well performance: Yield (gal/min)	Well performance: Drawdown (feet)	Use	pH	Remarks
T. 30 S., R. 36 E.																		
29caa	Fred Pallock	1968	117	6	28	X	Black and brown rock	--	7	8- 7-79	--	--	--	5	30	S	--	L, P 4 hr, no pump.
T. 31 S., R. 29 E.																		
20aaa	Rex Clemens	1968	502	6	142	X	Basalt	4,755	450	6-17-72	240	19	66	10	10	S	7.6	L, B 4 hr.
27bab	do	1968	605	8	18	X	Clay and gravel	4,724	130	11-30-68	660	10	50	22	4	S	6.8	L, B 2 hr.
T. 31 S., R. 31 E.																		
23cab	Harvey Dunbar	1978	508	12	30	X	Rock and cinders	4,790	13	7-21-79	--	--	--	--	--	I	--	L, no power to pump.
T. 31 S., R. 35 E.																		
1bbb	Fred Pallock	--	32	--	--	--	--	--	7.1	8- 8-79	740	14	57	--	--	H	7.2	Obs.
T. 31 S., R. 36 E.																		
21cda	U.S. Bureau of Land Management	1960	200	6	38	X	Clay and cinders	--	157.38	8- 8-79	--	--	--	20	--	S	--	Table Mountain well No. 6, no power to pump.
T. 32 S., R. 29 E.																		
14abc	U.S. Bureau of Land Management	1973	228	6	228	P, 208-228	Sandy clay	4,665	105.7	7-23-79	335	14	57	40	50	S	6.9	L, At 2 hr, Ca. Duhaime Flat well No. 17.
T. 32 S., R. 30 E.																		
1cda	U.S. Bureau of Land Management	1970	380	6	370	X	Brown rock	4,677	360	1-13-70	380	17	63	25	--	S	7.4	L, P 4 hr. Sand Valley well No. 19.
T. 32 S., R. 31 E.																		
25ccc	Merrill Glenn	1968	212	8	160	P, 100-160, X, 160-212	Fine sand and clay	4,577	97.8	7-19-79	370	11.4	53	30	--	S	7.2	L, B 2 hr.
33daa	U.S. Bureau of Land Management	1975	251	10	160	X	Sandy clay and gravel	4,589	118	7-21-79	250	19	66	6	43	S	7.7	L, P 1 hr. Reikens Corner well No. 63.
T. 32 S., R. 32 E.																		
2adc	State Highway Division of Parks	1975	78	6	78	P, 48-78	Black rock	4,189	2.5	7-19-79	480	12.7	55	20	40	H	6.9	L, P 5 hr, Ca. BLM Field Guard Station.
29cac	Merrill Glenn	1967	143	6	30	X	Basalt	4,575	1.15?	7-25-79	--	--	--	7	15	U	--	L, B 2 hr, abandoned.
T. 32 S., R. 32½ E.																		
7ddd	Stan Bennett	1971	325	6	20	X	Rock	4,315	86.9	7-19-79	290	20.8	70	40	--	H	7.5	L, B 2 hr. Camper Corral.
T. 32 S., R. 34 E.																		
36bcc	Hoyt Wilson	1969	490	16	465	P, 185-460, X, 465-490	Gravel, cinders, and clay	--	224.5	8- 8-79	160	13.5	56	2,500	194	I	8.0	L, P 8 hr, Ca.

Table 1.--Records of selected wells and springs--Continued

Well or spring number	Owner	Year completed	Depth of well (feet)	Diameter of well (inches)	Depth of casing (feet)	Finish	Character of material	Altitude (feet)	Water level: Feet below datum	Water level: Date	Specific conductance of water	Temperature (°C)	Temperature (°F)	Well performance: Yield (gal/min)	Well performance: Drawdown (feet)	Use	pH	Remarks
								T. 32 S., R. 35 E.										
19acd	U.S. Bureau of Land Management	1940	226	6	17	X	Lava	--	191	5- 9-40	--	--	--	9	--	U	--	L, abandoned.
24baa	Hoyt Wilson	1973	360	6	360	P, 245-263, 280-290, 300-320, 333-353	Sand, gravel, and cinders	--	200.6	1- 4-73	--	--	--	7.5	4	S	--	L, B 2 hr, winter use only.
35ddd	do	1973	547	6	547	P, 435-445, 455-465, 480-500, 508-520, 525-540	Lava	--	430	4-24-73	--	--	--	10	5	S	--	L, B 2 hr, winter use only.
								T. 32 S., R. 36 E.										
15ddd	U.S. Bureau of Land Management	--	160	--	--	--	--	--	--	--	--	--	--	--	--	S	--	White Sage well No. 8.
29daas	do	--	--	--	--	--	--	3,930	--	--	860	18.5	65	7.5	--	S	9.4	Ca. Crippled Horse Spring No. 45.
								T. 32 S., R. 37 E.										
15ddd	U.S. Bureau of Land Management	1968	400	6	366.5	P, 346-366, X, 366.5-400	Hard rock	--	360	7- 2-68	--	--	--	37	--	S	--	L, B 1 hr. Wildcat well #2, No. 6.
								T. 32½ S., R. 33 E.										
29aab	U.S. Bureau of Land Management	1972	110	6	103.6	P, 63-103, X, 103.6-110	Black rock	7,380	20.5	7-12-72	56	5.2	39	50	--	P	6.4	L, B 4 hr, Ca. Fish Lake Campground.
								T. 33 S., R. 29 E.										
13dbb	Jerry Miller	1968	180	12	17	X	Black rock and cinders	4,598	24.2	7-23-79	--	--	--	600	115	I	--	L, P 5 hr.
								T. 33 S., R. 30 E.										
2cab	Paul Howard	1957	400	14	55	--	Rock	4,594	117	11- 6-57	--	--	--	--	--	U	--	L (deepened section), abandoned.
								T. 33 S., R. 31 E.										
9adb	Catlow Valley Farms	1977	560	16	560	P, 200-560	Brown clay, rock, and fine gravel	4,557	90	12-16-77	--	--	--	1,350	170	I	--	L, P 2 hr.
31ddc	Rex Clemens	1973	610	16	610	P, 300-600,	Shale, gravel, and sand	4,548	70	11- 5-73	560	23.4	74	2,100	40	I	6.5	L, P 10 hr.
								T. 33 S., R. 34 E.										
24aab	Hoyt Wilson	1969	800	16	765	P, 148-760, X, 765-800	Clay and gravel	4,122	38.5	8- 7-79	--	--	--	2,500	208	I	--	L, P 9 hr.

Table 1.--Records of selected wells and springs--Continued

Well or spring number	Owner	Year completed	Depth of well (feet)	Diameter of well (inches)	Depth of casing (feet)	Finish	Character of material	Altitude (feet)	Water level: Feet below datum	Water level: Date	Specific conductance of water	Temperature (°C)	Temperature (°F)	Well performance: Yield (gal/min)	Well performance: Drawdown (feet)	Use	pH	Remarks
T. 33 S., R. 34 E.--Continued																		
24bbc	Alvord Ranch	1965	310	16	310	P, 100-300	Clay and gravel	--	29.9	8-13-79	--	--	--	900	140	U	--	L, P 10 hr, Obs.
T. 33 S., R. 35 E.																		
8dcb	U.S. Bureau of Land Management	1965	244	6	197	X	--	--	176	1- -65	--	--	--	14	--	U	--	B.
13bdcs	do	--	--	--	--	--	--	--	--	--	2,490	73.0	163	30	--	U	8.1	Mickey Hot Spring
T. 33 S., R. 37 E.																		
27cca	U.S. Bureau of Land Management	1968	389	6	389	P, 339-388	Black rock	--	317	8- 7-79	--	--	--	--	--	S	--	Ancient Lake well No. 68.
T. 33 S., R. 38 E.																		
11cbb	U.S. Bureau of Land Management	--	199	--	--	--	--	--	--	--	--	--	--	--	--	S	--	Wildcat well No. 1.
20bba	do	--	240	6	--	--	--	--	195	8- 7-79	--	--	--	--	--	S	--	Crassy Ridge well No. 66.
T. 34 S., R. 30 E.																		
9dab	Elijah Massey	1968	115	8	20	X	Sandstone	4,555	81.2	7-23-79	--	--	--	20	7	U	--	L, B 1 hr, abandoned.
T. 34 S., R. 31 E.																		
3cab	Rex Clemens	1973	685	16	685	P, 375-675	Fine gravel, clay, and sand	4,551	60	9- 8-73	480	16.2	61	1,500	38	I	6.7	L, P 10 hr, Ca.
18ddc	Catlow-Steens Corp.	--	--	8	--	--	--	4,549	117.65	8- 9-79	545	11.5	53	--	--	S	7.4	Ca.
23caa	Derrill Morger	1968	1,000	16	660	X	Sand and clay	4,552	54.75	2-25-68	--	--	--	1,700	100	U	--	L, P 12 hr, abandoned.
33daa	Catlow-Steens Corp.	--	--	--	--	--	--	4,554	74.6	8- 9-79	--	--	--	--	--	U	--	McBurney well.
T. 34 S., R. 32 E.																		
21ccb	Roaring Springs Ranch	1966	900	16	310	P, 125-309, X, 310-900	Sand, gravel, and clay	4,564	44.15	7-24-79	230	12	54	2,000	85	I	6.4	L, P 28 hr.
T. 34 S., R. 34 E.																		
10bcd	Alvord Ranch (E. Davis)	1965	337	16	327	P, 100-327, X, 327-337	Clay and gravel	4,105	12.08	8-13-79	--	--	--	1,900	160	U	--	L, P 10 hr.
15bca	do	1960	300	12	263	X	Sand and gravel	4,101	8.73	do	--	--	--	1,000	64	U	--	L, P 6 hr, Obs.
32dbas	U.S. Bureau of Land Management	--	--	--	--	--		4,070	--	--	4,590	76.0	169	130	--	U	6.7	Alvord Hot Springs.
T. 34 S., R. 35 E.																		
3acc	U.S. Bureau of Land Management	1949	196	6	36	--	--	--	11.1	8-13-79	--	--	--	--	--	U	--	Alvord well No. 1.

Table 1.--Records of selected wells and springs--Continued

Well or spring number	Owner	Year completed	Depth of well (feet)	Diameter of well (inches)	Depth of casing (feet)	Finish	Character of material	Altitude (feet)	Water level: Feet below datum	Water level: Date	Specific conductance of water	Temperature (°C)	Temperature (°F)	Well performance: Yield (gal/min)	Well performance: Drawdown (feet)	Use	pH	Remarks
T. 34 S., R. 35 E.--Continued																		
10dcd	U.S. Bureau of Land Management	1949	60	6	48	X	--	--	4.8	8-13-79	--	--	--	--	--	U	--	Alvord well No. 2.
27bdd	do	1954	--	--	--	--	--	--	--	--	--	--	--	--	--	U	--	
T. 35 S., R. 31 E.																		
23bad	Catlow-Steens Corp.	--	--	--	--	--	--	4,543	--	--	--	--	--	--	--	U	--	
32ddc	U.S. Government	1936	138	6?	--	--	Cinders and gravel	4,547	Dry	7-25-79	--	--	--	--	--	U	--	Catlow well No. 2.
T. 35 S., R. 32 E.																		
10bdc	Uland	1978	191	6	151.7	X	Sandy clay, gravel, and rock	4,570	14	10-30-78	175	14.1	57	15	76	H	6.2	L, P 1½ hr, Ca.
T. 35 S., R. 33 E.																		
14aab	Henry Blair	1963	36	6	35	X	Sand and gravel	4,240	8	8- 9-63	89	15	60	42	15	H	7.6	L, B 1 hr.
14abb	do	1973	400	16	400	P, 100-280, 280-390	Coarse gravel	4,270	10	2-13-72	250	14	57	50	3	I	7.7	L, B 6 hr, Ca.
23bad	do	1977	614	16	614	P, 184-424	Sand, gravel, and clay	4,205	30	7-12-77	--	--	--	2,300	146	I	--	L, P 8 hr.
34dcd	Andrew Shull	1958	170	6	--	--	Sand and gravel	4,020	18.02	12-11-68	--	--	--	--	--	U	--	Obs.
T. 36 S., R. 32 E.																		
23bcb	U.S. Government	1936	120	6?	--	--	Clay, sand, and gravel	4,542	94	1936	--	--	--	--	--	U	--	L. Catlow well No. 1.
T. 36 S., R. 33 E.																		
3aba	Allied Properties, Inc.	--	403	--	--	--	Gravel and lava	4,105	13.1	8-13-79	--	--	--	--	--	--	--	L, Obs.
10aaa	Kueny Ranch	--	--	--	--	--	--	4,061	F	8-14-79	132	12.7	55	--	--	S	8.2	Flowing from pipe 3 ft above surface.
16caa	Frazier	--	107	--	--	--	--	4,105	--	--	590	15	59	--	--	H	8.1	
16dcb	do	--	180	--	--	--	Sand and gravel	4,078	24.3	8-11-79	--	--	--	--	--	I	--	Obs.
16ddc	do	--	35	--	--	--	--	4,066	--	--	290	12	59	--	--	S	7.4	
T. 37 S., R. 31 E.																		
12aca	U.S. Bureau of Land Management	--	309	6?	--	--	--	4,544	6.5	7-25-79	--	--	--	--	--	U	--	Coyote Rim well No. 6. Abandoned.
T. 37 S., R. 32 E.																		
4aaa	Bass Haines	1936	277	6?	--	--	--	4,520	148.7	7-26-79	--	--	--	--	--	U	--	L. Egypt well.
17daa	U.S. Bureau of Land Management	--	431	6?	--	--	--	4,579	Dry	7-26-79	--	--	--	--	--	U	--	Early Pass well No. 14.

Table 1.--Records of selected wells and springs--Continued

Well or spring number	Owner	Year com-pleted	Depth of well (feet)	Diameter of well (inches)	Depth of casing (feet)	Finish	Character of material	Alti-tude (feet)	Water level: Feet below datum	Water level: Date	Specific conduct-ance of water	Temper-ature (°C)	Temper-ature (°F)	Well performance: Yield (gal/min)	Well performance: Draw-down (feet)	Use	pH	Remarks
								T. 37 S., R. 32½ E.										
7dads	U.S. Bureau of Land Management	--	--	--	--	--	--	4,586	--	--	120	13	55	--	--	S	6.4	CC Troughs Spring No. 6. Ca.
								T. 37 S., R. 32 3/4 E.										
24cdas	U.S. Bureau of Land Management	--	--	--	--	--	--	4,800	--	--	209	13	55	1	--	S	7.8	South Andrews Spring No. 28. Ca.
								T. 37 S., R. 33 E.										
7aacs	U.S. Bureau of Land Management	--	--	--	--	--	--	4,245	--	--	510	21.1	70	--	--	S	7.6	
9acb	Kurtz	1960	171	8	168	P, 3-?	Clay and sand	4,056	4.5	8-11-79	--	--	--	600	12	U	--	L, P 72 hr.
11ccds	U.S. Bureau of Land Management	--	--	--	--	--	--	4,055	--	--	2,190	87.0	189	5	--	U	7.5	Near Hot Borax Lake. Ca.
								T. 37 S., R. 34 E.										
22aac	U.S. Bureau of Land Management	1957	119	6	119	P, 95-116	Sand and gravel	--	94.55	8-10-79	--	--	--	27	5	S	--	L, B 1 hr, Calderwood Desert well No. 30.
31bad	do	1958	61	6	61	P, 33-58	do	4,081	22.38	do	--	--	--	30	11	S	--	L, B 1 hr, Black Point well No. 32.
								T. 38 S., R. 32 E.										
29bab	U.S. Bureau of Land Management	1963	702	10	385	X	Porous lava and sandstone	4,928	616	9-24-63	--	--	--	10	--	S	--	L, B 4 hr, Busher well No. 22.
33cad	do	--	521	8	--	--	--	4,706	Dry	7-25-79	--	--	--	--	--	U	--	Funnel Canyon well No. 23.
								T. 38 S., R. 34 E.										
24bdd	Wallace Coleman	1969	32	6	31	X	Gravel	4,243	6.5	6-30-79	1,000	14	57	44	5	H,I	7.2	
								T. 39 S., R. 33 E.										
23ccc	U.S. Bureau of Land Management	1955	575	6	575	X	Gravel	5,045	445.5	10-30-55	--	--	--	8	20	S	--	L, B, S. Rincon well No. 27.
25bcas	do	--	--	--	--	--	--	5,050	--	--	130	22	72	--	--	S	8.2	Ca, Dip Spring.
								T. 39 S., R. 35 E.										
4ccd	H. Dixon	1963	370	14	370	P, 100-160	Sand and gravel	--	34.49	3- 1-78	280	13.5	56	1,760	54	I	7.9	P 10 hr, Obs.
23cdc	Wallace Coleman	1978	408	16	408	P, 112-408	Gravel, sand and clay	--	23	1-22-78	278	14	57	2,950	115	I	8.1	L, P 17½ hr.
25dba	Trout Creek Ranch	--	400	--	--	--	--	--	10	1979	155	13.5	56	--	--	I	7.5	Obs.

Table 1.--Records of selected wells and springs--Continued

Well or spring number	Ownar	Year com-pleted	Depth of well (feet)	Diameter of well (inches)	Depth of casing (feet)	Finish	Character of material	Alti-tude (feet)	Water level: Feet below datum	Water level: Date	Specific conduct-ance of water	Temper-ature (°C)	Temper-ature (°F)	Well performance: Yield (gal/min)	Well performance: Draw-down (feet)	Use	pH	Remarks
T. 39 S., R. 36 E.																		
7bdd	U.S. Bureau of Land Management	1958	126	6	125	P, 95-120, X, 125-126	Sand, clay, cinders, and gravel	--	72	1-16-58	--	--	--	30	6	U	--	L, B 1 hr, Little Butte well No. 31.
31acd	Northrup	--	--	--	--	--	--	--	11.7	8-11-79	278	11	52	--	--	I	7.3	
T. 39 S., R. 37 E.																		
16s	U.S. Bureau of Land Management	--	--	--	--	--	--	--			1,168	52.0	26	50	--	U	6.8	Near Trout Creek.
T. 40 S., R. 36 E.																		
7bcb	U.S. Bureau of Land Management	1951	60	6	60	P, 12-60	Clay	--	4	6-19-51	--	--	--	30	--	U	--	L, Pueblo wall #1, No. 21.
11ddd	do	1967	700	6	700	P, 676-699	Sandstone	--	560.3	9-23-67	--	--	--	13.5	33	S	--	L, B 2-3/4 hr, Antelope Springs well No. 33.
19ddd	do	--	59	6	--	--	--	--	26.67	8-11-79	550	12	54	--	--	S	7.3	Ca, Pueblo Valley well No. 29.
T. 40 S., R. 37 E.																		
28babs	U.S. Bureau of Land Management	--	--	--	--	--	--	--	--	--	--	--	--	--	--	S	--	Red Mountain Spring No. 46.
T. 41 S., R. 33 E.																		
2aab	Ronald McLean	1977	700	12	127	P, 90-117, X, 127-700	Clay, sand, and gravel	--	8.2	8- 8-79	--	--	--	411	155	I	--	L, P 16 hr.
2dba	do	1977	50	--	--	--	--	--	--	--	230	12	54	--	--	H	6.8	Ca.
14ccd	U.S. Bureau of Land Management	1955	55	6	42.7	X	Gravel and sand-stone	4,140	14.7	8- 8-79	--	--	--	30	9	U	--	L, B, Oregon End well No. 26.
T. 41 S., R. 35 E.																		
13cdb	U.S. Bureau of Land Management	1956	85	8	75	X	Gravel and sand	4,115	45.3	7-26-79	--	--	--	30	47	U	--	L, B, South Sandhills well No. 24. Abandoned.
20acb	William Moser	1978	351	12	340	X	Sand, clay, and gravel	--	94.45	do	650	13.1	55	2,150	260	I	7.7	L, P 12 hr, Ca.
T. 41 S., R. 36 E.																		
8cca	U.S. Bureau of Land Management	--	110	--	--	--	--	--	--	--	240	15	59	--	--	S	8.3	Windmill.
T. 41 S., R. 37 E.																		
1abds	U.S. Buraau of Land Management	--	--	--	--	--	--	--	--	--	50	4.4	40	7	--	S	6.8	Government Corrals Spring No. 10, Ca.

Table 2.--Drillers' logs of selected wells

Materials	Thickness (feet)	Depth (feet)
20S/30E-18bda. R. F. Smith. Altitude 4,280 ft. Drilled by Orvail Buckner, 1978. Casing: 6-in. diam to 19 ft; unperforated		
Sandstone, brown	15	15
Lava, mild	5	20
Clay, blue	80	100
22S/26E-30dbd. Carl Mayo. Drilled by Gilstrap Water Well Drilling, 1968. Casing: 10-in. diam to 60 ft; perforated 36-60 ft		
Gravel	24	24
Clay, yellow	10	34
Gravel, red to black	6	40
Clay, with gravel	8	48
Gravel, red to black	8	56
Clay, red to black	39	95
Cravel, red to black	5	100
22S/30E-27ddc. W. W. Arntz. Altitude 4,230 ft. Drilled by Crane Drilling Co., 1961. Casing: 12-in. diam to 40 ft; unperforated		
Soil	3	3
Clay	9	12
Lava, red	22	34
Rock, gray	29	63
Cravel	64	127
22S/31E-28abb. Jack Drinkwater. Altitude 4,285 ft. Drilled by Rossberg & Son Irrigation, 1971. Casing: 6-in. diam to 30 ft; unperforated		
Soil	1	1
Cravel	2	3
Sand, coarse	22	25
Lava	75	100
Sandstone, with clay	60	160
Pumice	55	215
Lava	1	216
22S/31E-28dda. Harry Pon. Altitude 4,170 ft. Drilled by Holloway Drilling Co., 1961. Casing: 12-in. diam to 22 ft; unperforated		
Soil	16	16
Sand	4	20
Clay	2	22
Lava, rock	73	95
Clay, hard	137	232
Cravel and cinders	3	235
Clay, yellow, sticky	33	368
Cinders, black	2	370
Clay, yellow, sticky	90	460
Cravel, pea-sized	2	462
Clay, yellow	28	490
23S/26E-5bab. Ceorge McGee. Drilled by Davidson Drilling Service, 1973. Casing: 8-in. diam to 32 ft; unperforated		
Clay, brown	125	125
Claystone, brown	16	141
23S/26E-23ddd. George McCee. Drilled by Gilstrap Water Well Drilling, 1968. Casing: 10-in. diam to 20 ft; unperforated		
Gravel, coarse	16	16
Clay, brown	8	24
Gravel, with clay	56	80
23S/26E-28cba. U. S. Bureau of Land Management. Altitude 4,400 ft. Drilled by Skinner & Sons, 1973. Casing: 6-in. diam to 192.4 ft; unperforated		
Rock, black and red	128	128
Obsidian, brown to black	45	173
Gravel, black	27	200
23S/27E-7caa. Gene Clark. Drilled by Orvail Buckner, 1978. Casing: 16-in. diam to 192 ft; perforated 170-192 ft		
Soil	4	4
Gravel	8	12
Claystone	18	30
Cinders and boulders	370	400
Cinders and fine gravel	7	407
23S/27E-19cdd. Cene Clark. Drilled by Orvail Buckner, 1978. Casing: 6-in. diam to 20 ft; unperforated		
Soil	6	6
Clay	4	10
Gravel	2	12
Clay, brown	30	42
Sandstone, with gravel	276	318
Clay, red, hard	17	335
Sandstone, with gravel	190	525
23S/27E-27bac. Hoover Cattle Co. Drilled by Gilstrap Water Well Drilling, 1968. Casing: 10-in. diam to 105 ft; unperforated		
Soil	5	5
Gravel, coarse	25	30
Sand, brown	70	100
Clay, brown	15	115
Sand, brown and gray	5	120
Clay, brown	40	160
Sand, coarse	20	180
23S/28E-35dad. Oregon State Highway Department. Drilled by Dale Crawford Drilling, 1969. Casing: 6-in. diam to 497 ft; perforated 397-497 ft		
Sandstone, tan to dark brown	325	325
Sandstone, with gravel	13	338
Sandstone, reddish brown to gray	159	497
23S/31E-5aac. Harry Pon. Altitude 4,157 ft. Drilled by Holloway Drilling Co., 1961. Casing: 12-in. diam to 95 ft; perforated 18-34 ft, 52-56 ft, 69-74 ft, and 93-95 ft		
Soil	18	18
Clay and gravel	77	95
Lava	83	178
Gravel	2	180
Clay, yellow	75	255
Gravel	145	400
23S/31E-16dbb. L. H. Hill. Altitude 4,146 ft. Drilled by P. S. Weitenhiller and A. A. Durand, 1930. Casing: 12-in. diam to 117 ft, 8-in. diam 155-300 ft; perforated 37-117 ft and 160-240 ft		
Soil	9½	9½
Gravel, loose; cemented layers 1 ft thick at 50 and 75 ft	74½	84
Clay	6	90
Gravel, black, coarse, loose; coarser toward bottom	27	117
Clay, blue	38	155
Gravel, fine, or sand, coarse	105	260
Clay	8	268
Sand, grains as large as 1/8-in. diam, black; some pebbles as large as 2-in. diam; considerable fine silt	32	300
24S/23E-9ddb. U. S. Bureau of Land Management. Drilled in 1958; driller unknown. Casing: 6-in. diam to 477 ft; perforated to 477 ft		
Sand and gravel	263	263
Clay, sandy	24	287
Sand and gravel	146	433
Cinders, red	44	477

Table 2.--Drillers' logs of selected wells--Continued

Materials	Thickness (feet)	Depth (feet)
24S/25E-15cbb. Squaw Butte Experimental Station. Altitude 4,863 ft. Drilled by Western Drilling Co., 1967. Casing: 6-in. diam (deepened well)		
Sand, fine	45	625
Volcanic rock, red	45	670
24S/26E-3bbb. U. S. Bureau of Land Management. Drilled in 1957; driller unknown. Casing: 6-in. diam to 247 ft; perforated 200-230 ft		
Sand and gravel	15	15
Sand, gray, brown, and pink	194	209
Clay	4	213
Sandstone, brown	34	247
24S/27E-10acc. Silver Creek Ranch. Drilled by Orvail Buckner, 1978. Casing 18-in. diam to 38 ft; unperforated		
Gravel, brown, with clay	35	35
Claystone, brown	50	85
Lava	45	130
Clay, hard	4	134
Sandstone, gray to brown, hard	101	235
Clay, blue-green, sticky	100	335
Sandstone, light-gray	18	353
Clay, brown	10	363
Sandstone, brown to black	32	395
Clay, green, sticky	13	408
24S/30E-1abd. O. D. Hotchkiss. Altitude 4,134 ft. Drilled by Boyer and Koeneman, 1930. Deepened from 472 ft to 564 ft by Western Drilling Co., 1964. Casing 10-in. diam to 117 ft; unperforated		
Soil	60	60
Sand and gravel; first artesian flow	22	82
Clay, blue	15	97
Gravel; second artesian flow	12	109
Clay, blue, soft	98	207
Clay, yellow	10	217
Clay, blue, soft	28	245
Clay, yellow	10	255
Clay, blue, hard	58	313
Shale, green	39	352
Sandstone; third artesian flow	106	458
Rock, red	19	477
Soapstone; fourth artesian flow	1	478
Rock, red, volcanic, hard	86	564
24S/30E-7cdd. Adolf Kisle. Altitude 4,155 ft. Drilled by McGuire Drilling Co., 1962. Casing 18-in. diam to 347 ft; perforated 100-342 ft, 342-347 ft		
Soil	12	12
Sand and gravel	16	28
Clay, brown	12	40
Gravel, medium	4	44
Clay and gravel	76	120
Cinders	225	345
Lava, hard	2	347
24S/30E-26ddc. John Campbell. Altitude 4,136 ft. Drilled by John A. Van Meter, 1959. Casing: 16-in. diam to 150 ft; perforated 90-95 ft, 110-115 ft, 130-135 ft		
Hardpan	4	4
Sand and gravel	54	58
Clay, yellow and sand	12	70
Clay	111	181
Pumice and gravel	3	184
Clay, green	59	243
Sand and gravel	9	252
Shale, gray and black	249	501
24S/31E-28bcc. Harney County. Altitude 4,126 ft. Drilled by U. S. Geological Survey, 1936 Casing: unknown, diam to 15 ft; unperforated		
Soil	4	4
Clay, fine	4	8
Sand, fine	2	10
Sand and gravel, fine	2	12
Sand and gravel, coarse	3	15
25S/28E-25dbb. Don Miller. Drilled by Crane Drilling, 1957. Casing: 8-in. diam to 44 ft; unperforated		
Clay	12	12
Gravel	100	112
25S/29E-29caa. Hurlburt Ranches, Inc. Drilled by James L. Hurlburt, 1978. Casing: 16-in. diam to 200 ft; perforated 60-80 ft and 100-120 ft		
Soil, brown	1	1
Sand, with fine gravel	9	10
Clay, sandy	52	62
Sand, coarse, with fine gravel	58	120
Clay, green, with streaks	240	360
Clay, brown	45	405
Basalt, black	14	419
Clay, brown	38	457
25S/31E-4cba. James Stahl. Altitude 4,140 ft. Drilled by Edgar L. Koeneman, 1962. Casing: 12-in. diam to 90 ft; unperforated		
Soil	3	3
Sand and clay	167	170
25S/31E-29ccb. Edgar Koeneman. Altitude 4,170 ft. Drilled by Edgar L. Koeneman, 1963. Casing: 8-in. diam to 104 ft; perforated 70-80 ft		
Soil	2	2
Gravel and sand, cemented	68	70
Gravel, some water	11	81
Clay, blue	21	102
Gravel, cemented	45	147
Clay, blue	60	207
Gravel, some water	2	209
26S/26E-13cdd. U. S. Bureau of Land Management. Drilled in 1957; driller unknown. Casing: 6-in. diam to 121 ft; perforated 103-118 ft		
Soil	3	3
Sand and gravel	75	78
Lava	5	83
Sand and clay	4	87
Lava	24	111
Sand and clay	6	117
Lava	36	153
26S/29E-18aac. Hurlburt Ranches, Inc. Drilled by Calvin C. Bram. 1957. Casing: 6-in. diam to 54 ft; unperforated		
No record	56	56
Gravel	29	85
Sand and gravel	19	104

Table 2.--Drillers' logs of selected wells--Continued

Materials	Thickness (feet)	Depth (feet)
26S/30E-18dad. Mike Stafford. Altitude 4,110 ft. Drilled by Rossberg & Son Irrigation, 1975. Casing: 12-in. diam to 200 ft; unperforated		
Sand	2	2
Clay, yellow and green	88	90
Sand and clay	20	110
Clay, blue	40	150
Sand and gravel	30	180
Sand, fine	20	200
Pumice, with clay and gravel	82	282
Clay, gray	103	385
Gravel and pumice	15	400
Clay, brown	30	430
26S/31E-10dca. William Cherry, Jr. Altitude 4,095 ft. Drilled by Rossberg & Son Irrigation, 1970. Casing: 6-in. diam to 348 ft; unperforated		
Soil and clay	20	20
Clay, blue	10	30
Sand, blue	80	110
Clay, blue	255	365
26S/31E-18dbc. M. Davis. Altitude 4,113 ft. Drilled by Edgar L. Koeneman, 1967. Casing: 6-in. diam to 175 ft; unperforated		
Soil	3	3
Clay, yellow, sandy	6	9
Sand, black, muddy	31	40
Cinders, black	6	46
Mud, blue	124	170
Shale, gray	158	328
Cinders, black	3	331
Lava, broken	4	335
26S/31E-26bba. Harney County Land Development Co. Drilled by McGuire Drilling Co., 1962. Casing: 6-in. diam to 230 ft; perforated 90-225 ft		
Soil	12	12
Gravel, coarse	13	25
Clay, brown	5	30
Sand, black	8	38
Shale, blue	149	187
Gravel, coarse	43	230
26S/31E-33ccc. Larry Dunn. Altitude 4,110 ft. Drilled by Forrest Skinner, 1960. Casing: 12-in. diam to 70 ft; unperforated		
Soil	20	20
Clay, greenish-blue, sticky	36	56
Shale, greenish-blue	14	70
Sandstone	3	73
Clay, blue	57	130
Clay, white, sticky	5	135
Sandstone	30	165
Clay, black	10	175
Clay, white	55	230
Sandstone	89	319
Clay, brown, sticky	10	329
Sandstone	5	334
Clay, brown, sticky	16	350
Clay, green, sandy	110	460
Shale, blue	65	525
26S/32E-33dba. Rex Taylor. Altitude 4,099 ft. Drilled by McGuire Drilling Co., 1962. Casing: 14-in. diam to 328 ft; perforated 90-318 ft		
Soil	12	12
Shale, black	58	70
Gravel, fine	41	111
Shale, brown	40	151
Cinders	19	170
Shale, blue	84	254
Gravel, fine	17	271
Lava	33	304
Shale	24	328
27S/25E-16ccd. John Peila. Drilled by Jim Smiley, 1969. Casing: 6-in. diam to 61 ft; unperforated		
Clay	52	52
Lava, gray	32	84
Sandstone, brown	10	94
Lava, gray	42	136
Lava, red	6	142
Lava, gray	33	175
Clay and sand	15	190
Lava, red and gray	190	380
27S/29E-3ccc. Hurlburt Ranches, Inc. Altitude 4,101 ft. Drilled in 1931; driller unknown. Casing: unknown diam to 60 ft		
Soil	13	13
Clay	35	48
Gravel	12	60
27S/29E-9caa. Vergil Moon. Drilled by Edgar L. Koeneman 0-95 ft in 1967, and Western Drilling Co. 88-200 ft in 1967. Casing: 12-in. diam to 65 ft; perforated 20-30 ft, 35-40 ft, and 52-63 ft		
Soil	7	7
Rock, gray, broken	58	65
Rock, solid	73	138
Cinders, multicolored	62	200
27S/30E-34bab. U.S. Bureau of Land Management. Drilled by Orvail Buckner, 1976. Casing: 6-in. diam to 356 ft; unperforated		
Soil, sandy loam	2	2
Gravel, fine, cemented	4	6
Clay, yellowish-brown	114	120
Clay, blue	90	210
Gravel, metamorphic green	88	298
Gravel, brown	35	333
Clay, blue	23	356
27S/31E-9bba. Malheur Field Station. Altitude 4,115 ft. Drilled by Western Drilling Co., 1965. Casing: 12-in. diam to 166 ft; perforated 136-166 ft		
Soil	3	3
Clay	7	10
Sand	4	14
Clay, blue	35	49
Gravel, coarse, with boulders	8	57
Clay, blue, yellow, and brown	268	325
Limestone	21	346
Clay and boulders	74	420
Clay, blue, sticky	80	500

Table 2.--Drillers' logs of selected wells--Continued

28S/30E-24add. George Hamilton. Drilled by Jack McClure, 1964; extended by Jack McClure, 1965. Casing: 6-in. diam to 190 ft; perforated 45-60 ft

Materials	Thickness (feet)	Depth (feet)
Soil	8	8
Clay, yellow	47	55
Clay and sand	1	56
Clay, blue	34	90
Ash, white	6	96
Clay, yellow and blue	182	278
Sand, coarse	2	280
Clay, blue	150	430
Gravel, mixed with clay	80	510
Clay, blue	10	520

29S/32E-27bdb. Harney County. Altitude 4,270 ft. Drilled by Rick Knoblock Drilling, 1957. Casing: 6-in. diam to unknown depth.

Materials	Thickness (feet)	Depth (feet)
No record	180	180
Soapstone, brownish-gray	215	395
Shale, blue	35	430

29S/32E-32cba. Marvin Morger. Altitude 4,180 ft. Drilled by Rossberg & Son Irrigation, 1959. Casing: 6-in. diam to 38 ft; unperforated

Materials	Thickness (feet)	Depth (feet)
Soil	20	20
Gravel, pea-sized	30	50
Cinders, red, and gravel	10	60
Gravel, reddish	10	70
Basalt, hard	1	71

29S/32E-35cac. U.S. Bureau of Land Management. Altitude 4,433 ft. Drilled by W. E. Majors, 1962. Casing: 6-in. diam to unknown depth; unperforated

Materials	Thickness (feet)	Depth (feet)
Soil	3	3
Boulders	32	35
Sandstone, multi-colored	290	325

30S/31E-10cdb. Fred Witzel. Altitude 4,155 ft. Drilled by Rossberg & Son Irrigation, 1963. Casing: 6-in. diam to 100 ft; unperforated

Materials	Thickness (feet)	Depth (feet)
Soil	10	10
Sand, black, fine	30	40
Clay, yellow	15	55
Gravel	15	70
Clay, yellow	35	105
Sandstone, black	10	115
Clay, yellow	45	160
Basalt	80	240

30S/31E-36dad. U.S. Bureau of Land Management. Altitude 4,410 ft. Drilled by Jobe Drilling, Inc., 1979. Casing: 6-in. diam to 300 ft; perforated 260-300 ft

Materials	Thickness (feet)	Depth (feet)
Soil	2	2
Volcanic ash, red	108	110
Lava, gray	150	260
Mudstone, gray	60	320
Clay, red	10	330
Lava, black	230	560

30S/32E-1dcc. U.S. Bureau of Land Management. Altitude 4,498. Drilled by Jack McClure, 1959. Casing: 6-in. diam to 5 ft; unperforated

Materials	Thickness (feet)	Depth (feet)
Soil	3	3
Rock, gray	122	125
Rock, red	45	170
Clay, red and gray	108	278
Sandstone	42	320
Clay, with gravel	14	334
Clay, red and yellow	36	370

30S/32E-11baa. U.S. Bureau of Land Management. Altitude 4,514 ft. Drilled by Dick Akins Well Drilling, 1971. Casing: 6-in. diam to 211 ft; unperforated

Materials	Thickness (feet)	Depth (feet)
No record	380	380
Basalt, gray	30	410

30S/36E-29caa. Fred Pallock. Drilled by Skinner & Sons, 1968. Casing: 6-in. diam to 28 ft; unperforated

Materials	Thickness (feet)	Depth (feet)
Soil, brown	1	1
Hardpan	2½	3½
Clay, brown, blue, and yellow	56½	60
Rock, black and brown	57	117

31S/29E-20aaa. Rex Clemens. Altitude 4,755 ft. Drilled by Raymond C. Gellatly, 1968. Casing: 6-in. diam to 142 ft; unperforated

Materials	Thickness (feet)	Depth (feet)
Soil and broken rock	8	8
Bentonite and broken rock	20	28
Sandstone, yellow and red	111	139
Volcanic rock, gray	23	162
Basalt and black and white limestone	27	189
Basalt	313	502

31S/29E-27bab. Rex Clemens. Altitude 4,724 ft. Drilled by Woerner Drilling Service, 1968. Casing: 8-in. diam to 18 ft; unperforated

Materials	Thickness (feet)	Depth (feet)
Soil	5	5
Clay, brown	153	158
Basalt, gray	168	326
Volcanic ash and red conglomerate	244	570
Clay, gray	35	605

31S/31E-23cab. Harvey Dunbar. Altitude 4,790 ft. Drilled by Highland Drilling Co., 1978. Casing: 12-in. diam to 30 ft; unperforated

Materials	Thickness (feet)	Depth (feet)
Soil	3	3
Clay, yellow, sandy	19	22
Volcanic rock, black and red	133	155
Clay, red, hard	13	168
Volcanic rock, black and red	200	368
Clay, black	2	370
Volcanic rock, black and red	138	508

32S/29E-14abc. U.S. Bureau of Land Management. Altitude 4,665 ft. Drilled by Skinner & Sons, 1973. Casing: 6-in. diam to 228 ft; perforated 208-228 ft

Materials	Thickness (feet)	Depth (feet)
Soil	5	5
Gravel, brown	15	20
Clay, brown	10	30
Lava, gray	70	100
Clay, brown, sandy	120	220
Sand, coarse and brown gravel	8	228

32S/30E-1cda. U.S. Bureau of Land Management. Altitude 4,677 ft. Drilled by Skinner & Sons, 1970. Casing: 6-in. diam to 380 ft; unperforated

Materials	Thickness (feet)	Depth (feet)
Sand, brown	8	8
Clay, red and brown, sandy	162	170
Sandstone, brown	95	265
Clay, brown, sandy	102	367
Rock, brown	13	380

Table 2.--Drillers' logs of selected wells--Continued

Materials	Thick-ness (feet)	Depth (feet)
32S/31E-25ccc. Merrill Glenn. Altitude 4,577 ft. Drilled by Woerner Drilling Service, 1968.. Casing: 8-in. diam to 160 ft; perforated 100-160 ft		
Overburden	25	25
Sand, brown	105	130
Clay, brown, sandy	80	210
Clay, red	2	212
32S/31E-33daa. U.S. Bureau of Land Management. Altitude 4,589 ft. Drilled by John W. McAllister, 1975. Casing: 10-in. diam to 160 ft; unperforated		
Soil	3	3
Sand & gravel, gray	17	20
Clay & sand, with boulders	231	251
32S/32E-2adc. State Highway Division of Parks. Altitude 4,189 ft. Drilled by Crawford Well Drilling, 1971. Casing: 6-in. diam to 78 ft; perforated 48-78 ft		
Soil, brown, heavy	3	3
Hardpan	1	4
Clay, brown	13	17
Sandstone, brown	9	26
Gravel, multicolored, water-bearing	11	37
Sandstone, brown	6	43
Rock, black, broken, water-bearing	35	78
32S/32E-9cac. Merrill Glenn. Altitude 4,575 ft. Drilled by Rossberg & Son Irrigation, 1967. Casing: 6-in. diam to 30 ft; unperforated		
Soil and boulders	30	30
Clay, yellow	60	90
Basalt, black	53	143
32S/32½E-7ddd. Stan Bennett. Altitude 4,315 ft. Drilled by Skinner & Sons, 1971. Casing: 6-in. diam to 20 ft; unperforated		
Soil and boulders	4	4
Rock, black and gray	136	140
Rock, cracks, water-bearing	185	325
32S/34E-36bcc. Hoyt Wilson. Drilled by Witt & Sons Drilling, 1969. Casing: 16-in. diam to 465 ft; perforated 185-460 ft		
Soil	4	4
Boulders, large	19	23
Clay, yellow	7	30
Clay and gravel	171	201
Lava, black	39	240
Clay and gravel, cinders	145	385
Clay, red, sticky	37	422
Clay and gravel	31	453
Gravel, coarse	15	468
Lava, broken	12	480
Lava	10	490
32S/35E-19acd. U.S. Bureau of Land Management. Drilled in 1940; driller unknown. Casing: 6-in. diam to 17 ft; unperforated		
Soil	2	2
Clay, yellow, hard	6	8
Boulders, brown	2	10
Clay and gravel	30	40
Lava, black, red, and yellow	50	90
Clay, yellow, soft	10	100
Sandrock, green and yellow, hard	22	122
Lava, black	104	226
32S/35E-24baa. Hoyt Wilson. Drilled by Witt & Sons, Drilling, 1973. Casing: 6-in. diam to 360 ft; perforated 245-263 ft, 280-290 ft, 300-320 ft, and 333-353 ft		
Soil	3	3
Gravel with clay	13	16
Lava	247	263
Clay, yellow	17	280
Clay, mixed with gravel	53	333
Sand, black, fine	20	353
Lava, black	7	360
32S/35E-35ddd. Hoyt Wilson. Drilled by Witt & Sons Drilling, 1973. Casing: 6-in. diam to 547 ft; perforated 435-445 ft, 455-465 ft, 480-500 ft, 508-520 ft and 523-540 ft		
Soil	2	2
Hardpan	3	5
Clay	20	25
Clay, mixed with gravel	93	118
Lava	429	547
32S/37E-15ddd. U.S. Bureau of Land Management. Drilled by Forrest Skinner, 1968. Casing: 6-in. diam to 366.5 ft; perforated 346-366 ft		
Soil, brown, with black rock	180	180
Clay, gray, with coarse sand	12	192
Lava	123	315
Rock, tan, soft	15	330
Rock, multicolored, water-bearing	70	400
32½S/33E-29aab. U.S. Bureau of Land Management. Altitude 7,380 ft. Drilled by Skinner & Sons, 1972. Casing: 6-in. diam to 103.5 ft; perforated 63-103 ft		
Soil with gravel, reddish brown, some water	35	35
Lava	65	100
Lava, broken, water-bearing	10	110
33S/29E-13dbb. Jerry Miller. Altitude 4,598 ft. Drilled by Jerry Miller, 1969. Casing: 12-in. diam to 17 ft; unperforated		
Clay, yellow	17	17
Rock, black	80	97
Cinders, red	11	108
Rock, black	72	180
33S/30E-2cab. Paul Howard. Altitude 4,594 ft. Drilled by Forrest Skinner, 1957. Casing: 14-in. diam to 55 ft		
No record	116	116
Lava rock	284	400
33S/31E-9adb. Catlow Valley Farms. Altitude 4,557 ft. Drilled by Highland Drilling Co., 1977. Casing: 16-in. diam to 560 ft; perforated 200-560 ft		
Soil	1	1
Clay and rock, brown	184	185
Rock, brown, and fine gravel	17	202
Clay and rock, brown	133	335
Rock, brown, and gravel	17	352
Clay, brown, with loose rock	13	365
Clay and loose rock, brown	195	560

Materials	Thickness (feet)	Depth (feet)
33S/31E-31ddc. Rex Clemens. Altitude 4,548 ft. Drilled by McGuire Drilling, 1973. Casing: 16-in. diam to 610 ft; perforated 300-600 ft		
Soil	8	8
Shale, blue	65	73
Sand, fine	15	88
Shale, blue	18	106
Sand, fine	2	108
Clay, blue	124	232
Sand, fine	24	256
Clay, blue	31	287
Sand, fine	10	297
Clay, blue	83	380
Gravel, fine	8	388
Clay, blue	83	471
Sand, fine	17	488
Clay, blue	43	531
Sand, fine	13	544
Clay, blue	36	580
Sand, medium	20	600
Clay, blue	10	610
33S/34E-24aab. Hoyt Wilson. Altitude 4,122 ft. Drilled by Witt & Sons Drilling, 1969. Casing: 16-in. diam to 765 ft; perforated 148-603 ft and 635-760 ft		
Clay and gravel, brown	160	160
Clay, brown, soft	15	175
Clay and gravel	240	415
Clay, red, sticky	60	475
Clay and gravel	128	603
Clay, yellow	52	655
Sandstone	2	657
Clay, red, sandy	108	765
Clay and gravel	35	800
33S/34E-24bbc. Alvord Ranch. Drilled by McGuire Drilling Co., 1965. Casing: 16-in. diam to 310 ft; perforated 100-300 ft		
Soil	7	7
Cravel	10	17
Clay, brown	5	22
Gravel, medium	34	56
Clay, brown	11	67
Cravel, medium	17	84
Clay, brown	12	96
Gravel	26	122
Clay, brown	8	130
Clay and gravel	12	142
Gravel	38	180
Clay, brown, and gravel	130	310
34S/30E-9dab. Elijah Massey. Altitude 4,555 ft. Drilled by Skinner & Sons, 1968. Casing: 8-in. diam to 20 ft; unperforated		
Clay, brown, sandy	2	2
Clay, brown	91	93
Sandstone, brown	22	115
34S/31E-3cab. Rex Clemens. Altitude 4,551 ft. Drilled by McGuire Drilling Co., 1973. Casing: 16-in. diam to 685 ft; perforated 375-675 ft		
Soil	8	8
Clay, brown, blue	179	187
Gravel, fine	16	203
Clay, blue, and fine sand	402	605
Clay, blue, and fine gravel	80	685
34S/31E-23caa. Derrill Morger. Altitude 4,552 ft. Drilled by Skinner & Sons, 1968. Casing: 16-in. diam to 660 ft; unperforated		
Soil, brown	62	62
Clay, tan with sand, water-bearing	68	130
Clay, multicolored	722	852
Rock, black and gray	23	875
Sandstone, dark-gray	125	1,000
34S/32E-21ccb. Roaring Springs Ranch. Altitude 4,564 ft. Drilled by William Wolgermitt, 1967. Casing: 16-in. diameter to 310 ft., perforated 125-309 ft		
Soil, brown	11	11
Sand, yellow	36	47
Clay, yellow, mixed with gravel	853	900
34S/34E-10bcd. Alvord Ranch (E. Davis). Altitude 4,105 ft. Drilled by McGuire Drilling Co., 1965. Casing: 16-in. diam 100-327 ft; perforated 100-327 ft		
Soil	10	10
Clay	12	22
Gravel and thin clay beds	69	91
Clay	21	112
Gravel and clay	20	132
Clay	26	158
Gravel and clay	39	197
Clay	19	216
Gravel, cemented	41	257
Clay	14	271
Gravel	19	290
Clay	23	313
Gravel	24	337
34S/34E-15bca. Alvord Ranch (E. Davis). Altitude 4,101 ft. Drilled by Rossberg & Sons Irrigation, 1960. Casing: 12-in. diam to 263 ft; unperforated		
Soil	3	3
Gravel and boulders	29	32
Clay and gravel	10	42
Gravel	88	135
Lava	14	149
Gravel, mixed	91	240
Conglomerate	20	260
Lava	40	300
35S/32E-10bdc. Uland. Altitude 4,570 ft. Drilled by H.S. McNinch Drilling, 1978. Casing: 6-in. diam to 151.7 ft; unperforated		
Soil, with boulders	3	3
Clay, brown	23	26
Clay, red, sandy, with fine gravel	108	134
Boulders	3	137
Clay, brown	44	181
Rock, broken	4	185
Clay, brown	6	191
35S/33E-14aab. Henry Blair. Altitude 4,240 ft. Drilled by Rossberg & Sons Irrigation, 1963. Casing: 6-in. diam to 35 ft; unperforated		
Soil	15	15
Sand and gravel, medium	19	34
Gravel, coarse	2	36
35S/33E-14abb. Henry Blair. Altitude 4,270 ft. Drilled by McGuire Drilling, 1973. Casing: 10-in. diam to 400 ft; perforated 100-280 ft and 280-390 ft		
Soil	8	8
Sand	7	15
Clay and gravel, mixed	252	267
Boulders	9	276
Clay and gravel	124	400

Materials	Thickness (feet)	Depth (feet)
35S/33E-23bad. Henry Blair. Altitude 4,205 ft. Drilled by Stadeli Drilling Co. in 1977. Casing 16-in. diam to 614 ft; perforated 184-424 ft		
Soil, gray	2	2
Clay and gravel, mixed	142	144
Clay, brown	11	155
Clay and gravel	230	385
Clay, brown, sandy	9	394
Clay and gravel, mixed	102	496
Clay, brown, sandy	18	514
Sand and gravel, medium brown	20	534
Clay, brown, sandy	11	545
Sand and gravel	69	614
36S/32E-23bcb. U.S. Government. Altitude 4,542 ft. Drilled in 1936; driller unknown. Casing: 6-in. diam to unknown depth		
Clay	40	40
Clay, hard	12	52
Sandstone	8	60
Clay and sand	26	86
Sand and gravel	34	120
37S/32E-4aaa. Bass Haines. Altitude 4,520 ft. Drilled in 1936; driller unknown. Casing: 6-in. diam to unknown depth		
Soil	6	6
Shale and sand	204	210
Basalt, black	46	256
Rock, brown	13	269
Gravel	8	277
36S/33E-3aba. Uland. Altitude 4,105 ft. Drilled by Rossberg & Son Irrigation, 1961		
Soil	24	24
Gravel and clay	246	270
Sandstone, soft	68	338
Lava	65	403
37S/33E-9acb. Kurtz. Altitude 4,056 ft. Drilled by James Calderwood, 1960. Casing: 8-in. diam to 168 ft; perforated 3 ft. to unknown depth		
Loam, sandy	12	12
Clay and sand, yellow, mixed	75	87
Gravel and sand	5	92
Clay, yellow	20	112
Clay, blue	30	142
Clay and sandrock	29	171
37S/34E-22aac. U.S. Bureau of Land Management. Drilled by U.S. Bureau of Land Management, 1957. Casing: 6-in. diam to 119 ft; perforated 95-116 ft		
Clay, sand, and gravel	61	61
Boulders	6	67
Sand and gravel	35	102
Sand and gravel, water-bearing	17	119
37S/34E-31bad. U.S. Bureau of Land Management. Altitude 4,081 ft. Drilled by U.S. Bureau of Land Management, 1958. Casing: 6-in. diam to 61 ft; perforated 33-58 ft		
Clay	12	12
Sand	10	22
Sand and gravel	29	51
Sand, coarse, water-bearing	10	61
38S/32E-29bab. U.S. Bureau of Land Management. Altitude 4,928 ft. Drilled by H.C. Cunningham, 1963. Casing: 10-in. diam to 385 ft; unperforated		
Soil and clay, brown, sandy	95	95
Lava	128	223
Crevice, water-bearing	58	281
Lava	49	330
Lava, broken	50	380
Rhyolite, gray, coarse	20	400
Lava	250	650
Sandstone, water-bearing	52	702
39S/33E-23ccc. U.S. Bureau of Land Management. Altitude 5,045 ft. Drilled by U.S. Bureau of Land Management, 1955. Casing: 6-in. diam to 575 ft; unperforated		
Gravel	20	20
Clay, firm	70	90
Clay, soft, sticky	23	113
Sand and gravel	75	188
Lava	182	370
Sandy material and red clay	90	460
Gravel and clay	91	551
Lava	6	557
Gravel and clay	18	575
39S/35E-23cdc. Wallace Coleman. Drilled by Wallace Coleman, 1978. Casing: 16-in. diam to 408 ft; perforated 112-408 ft		
Soil	1	1
Clay	27	28
Mixed gravel and clay	120	148
Sand and gravel, some clay	170	318
Clay, hard,brown	20	338
Sand and gravel	4	342
Clay, hard, sandy	56	398
Sand, pea gravel	10	408
39S/36E-7bdd. U.S. Bureau of Land Management. Drilled by U.S. Bureau of Land Management, 1958. Casing: 6-in. diam to 125 ft; perforated 95-120 ft		
Clay	30	30
Sand and clay	7	37
Clay, yellow, brown	41	78
Sand and clay, water-bearing	13	91
Clay, gravelly	24	115
Sand and clay, water-bearing	10	125
Clay	1	126
40S/36E-7bcb. U.S. Bureau of Land Management. Drilled in 1951; driller unknown. Casing: 6-in. diam to 60 ft; perforated 12-60 ft		
Soil, yellow	16	16
Clay	10	26
Clay, sandy	34	60
40S/36E-11ddd. U.S. Bureau of Land Management. Drilled by Skinner & Sons, 1967. Casing: 6-in. diam to 700 ft; perforated 676-699 ft		
Soil, brown, with boulders	17	17
Clay and gravel	619	636
Sandstone, brown, water-bearing	64	700

Materials	Thickness (feet)	Depth (feet)
41S/33E-2aab. Ronald McLean. Drilled by Rossberg & Sons Irrigation, 1977. Casing: 12-in. diam to 127 ft; perforated 90-117 ft		
Soil	5	5
Clay and gravel, brown	85	90
Chalk	30	120
Clay and gravel, green	345	465
Gravel, green, fine	55	520
Clay	10	530
Slate	5	535
Gravel, green and brown	65	600
Clay and gravel	15	615
Shale	10	625
Sandstone, white, hard	10	635
Clay and gravel, fine	50	685
Pumice	25	710
41S/33E-14ccd. U.S. Bureau of Land Management. Altitude 4,140 ft. Drilled by U.S. Bureau of Land Management, 1955. Casing: 6-in. diam to 42.7 ft; unperforated		
Clay and gravel	41	41
Sandstone	6	47
Gravel	2	49
Sandstone	6	55
41S/35E-13cdb. U.S. Bureau of Land Management. Altitude 4,115 ft. Drilled by U.S. Bureau of Land Management, 1956. Casing: 8-in. diam to 75 ft; unperforated		
Sand	27	27
Gravel, pea-sized	7	34
Clay, sandy, and gravel	17	51
Silt, mucky	5	56
Sand, water-bearing	2	58
Silt, dry	3	61
Gravel and sand, water-bearing	4	65
Gravel, cemented	5	70
Sand, water-bearing	1	71
Silt, dry	3	74
Gravel and coarse sand, water-bearing	11	85
41S/35E-20acb. William Moser. Drilled by William Moser, 1978. Casing: 6-in. diam to 340.3 ft; unperforated		
Gravel, coarse	70	70
Clay, light	5	75
Sand and gravel	75	150
Clay, light	1½	151½
Gravel, coarse and pea-sized	119½	271
Clay, light	9	280
Sand and gravel	71	351

Table 3.--Summary of observation-well data

Well number	Owner	Depth (feet)	Period of record		Depth to water, in feet below land surface				Remarks
			Begin	End	Highest	Date	Lowest	Date	
22S/30E-27ddc	Mrs. Werner Arntz	127	1966	--	38.06	7- 5-78	59.64	8-27-73	Hydrograph in figure 3.
22S/31E-28dda	Harry Pon	490	1966	--	13.30	11-18-76	31.52	11-17-77	
-34ccb	Jay Hoyt	288	1930	--	1.50	4-21-36	19.82	6- 6-74	Hydrographs in Ground Water Reports 16 and 18.
23S/27E-30abb	Green Valley Ranch	268	1962	--	65.64	5-23-75	80.76	9- 2-76	Hydrograph in figure 3 and Ground Water Report 18.
23S/30E-36bbc	Baker Ranch	--	1971	--	1.86	3- 3-77	8.38	11-17-77	
23S/31E-5aac	Harry Pon	400	1962	--	10.92	4-18-62	25.77	8-25-77	
-16bcc	Harney County	14	1936	1971	.80	4-16-52	9.10	1-15-36	Hydrograph in Ground Water Report 16.
-16dbb	L. H. Hill	300	1930	--	3.95	5-20-65	16.75	8-23-72	Hydrographs in figure 3 and Ground Water Reports 16 and 18.
-33cbc	Harney County	13	1936	1971	.28	5-22-65	8.57	12-11-68	
24S/27E-11bab	Silver Creek Ranch	400	1968	--	38.34	5-23-69	41.13	5-27-76	
24S/30E-7cdd	Adolf Kisle	347	1966	--	16.23	5-19-67	24.04	8-25-77	Hydrograph in figure 3.
-26ddc	John Campbell	501	1960	--	25.77	4-19-62	50.68	10-11-68	Hydrographs in Ground Water Reports 16 and 18.
24S/31E-28bcc	Harney County	17	1936	1969	2.76	4-16-52	13.06	9- 8-36	Hydrograph in Ground Water Report 18.
25S/30E-34aba	Forrest Reed	97	1963	--	25.88	5-21-63	29.10	6-29-77	Hydrograph in figure 3.
25S/31E-4cba	James Stahl	170	1962	1970	34.70	3- 3-70	37.67	9-11-68	
-29ccb	Edgar Koeneman	209	1964	1970	70.54	6-10-70	71.57	10-13-68	
26S/31E-26bba	Harney County Land Development Corp.	230	1965	1968	12.74	2-15-66	13.28	3- 4-65	
29S/37E-17cca	Fred Pallock	190	1965	--	92.44	5-19-65	100.92	8- 7-79	
-34ddd	M. J. Haines	147	1964	--	4.50	12-15-76	7.42	11-20-68	Hydrograph in figure 3.
31S/35E-1bbb	Fred Pallock	32	1954	--	2.35	8-20-75	18.12	5-21-64	Hydrograph in figure 3 and Ground Water Report 18.
33S/34E-24bbc	Alvord Ranch	310	1965	--	25.40	6- 5-74	56.69	5-17-67	Hydrograph in figure 3.
34S/34E-15bca	do	300	1962	--	4.27	6-19-73	27.43	12-11-68	Hydrograph in Ground Water Report 18.
35S/33E-34dcd	Andrew Shull	170	1958	1968	11.95	5-19-65	18.30	1-11-62	
36S/33E-3aba	Allied Properties, Inc.	403	1962	--	11.21	5-10-72	18.15	12-11-68	Hydrograph in Ground Water Report 18.
-16dcb	Gaylen Frazier	180	1969	--	17.96	5-21-75	21.69	12- 3-69	Hydrograph in figure 3.
39S/35E-4ccd	H. Dixon	370	1964	--	32.26	5-26-76	35.91	2-28-68	Do.
-25dba	Trout Creek Ranch	400	1967	--	6.33	do	12.81	9-20-72	

Table 4.--Chemical analyses of water from wells and springs

[Analyses by U.S. Geological Survey. Specific conductance and pH are field values, except as noted. Remarks: P is plasma-scan analysis; G is analysis from geothermal file]

Location no.	Depth of well (feet)	Date of col- lection	Milligrams per liter																			Sodium-adsorption-ratio (SAR)	Specific conduct- ance (micromhos/cm at 25°C)	pH	Temper- ature		Remarks
			Silica (SiO_2)	Iron (Fe)	Manganese (Mn)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO_3)	Carbonate (CO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrite (NO_2) + nitrate (NO_3) as N	Phosphorus, ortho as P	Boron (B)	Arsenic (As)	Dissolved solids, calculated from determined con- stituents	Hardness (Ca, Mg)	Noncarbonate hardness				(°C)	(°F)	
22S/30E-27ddc	127	7-23-68	55	0.01	--	10	4.8	13	4.5	82	0	5.2	2.5	0.2	2.5	--	0.05	--	138	44	0	0.9	161*	7.5*	14.0	57	
22S/31E-28abb	216	8- 9-79	4.0	.00	0.001	21	9.8	18	5.8	102	0	23	10	.3	3.4	--	.04	0.002	158	93	9	.8	276*	7.3	15.0	59	
23S/23E-27acb	508	7- 6-79	110	.05	.005	7	3	100	--	--	--	18	45	.3	--	--	3	.005	--	--	--	--	530	7.2*	27.0	81	P.
23S/26E-5bab	133	6-28-79	37	.0	<.001	8.2	4.2	13	2.1	67	0	2.1	2.6	.1	.33	--	.12	.000		38	0	.9	140	6.3	12.5	54	
23S/31E-5aac	400	7-23-68	58	.30	--	25	10	13	4.1	143	0	14	3	.4	1.4	--	.09	--	199	104	0	.56	270*	7.4*	11.0	52	
24S/27E-10acc	408	7- 5-79	47	.03	.04	18	3.7	10	2.3	87	0	6.6	2.5	.1	1.1	--	.15	.011	138	60	0	.6	161*	7.6	11.5	53	
24S/30E-1abd	564	9-11-68	46	.00	--	8.8	1.4	31	2.9	93	0	12	5	.5	1.1	--	.06	--	155	28	0	2.6	194*	8.1*	27.0	80	
25S/29E-29caa	457	7- 5-79	48	.00	.13	27	16	41	8.6	220	0	37	14	.6	.32	--	.16	.037	302	130	0	1.5	464*	7.7	11.5	53	
25S/32E-7bab	1,345	6-12-69	54	--	--	.5	.2	386	4.4	674	144	8	9	19	.1	--	--	.00	957	2	0	120	1,450*	9.3*	41.0	105	
26S/31E-33ccc	525	7-19-79	98	.01	.001	1	<1	300	--	--	--	22	67	9.6	--	--	3	.037	--	--	--	--	1,130	9.5	25.0	77	P.
27S/29½E-36ddas	Spring	1972	92	.05	.04	12	1.8	630	13.0	566	1	140	590	3.3	--	0.09	11.3	.60	1,810	--	--	--	2,970	7.3	68.0	154	G. Near Harney Lake.
27S/30E-14bbb	341	7- 5-79	35	.00	<.001	3.4	2.9	130	2.4	268	0	9.4	67	1.2	.02	--	1.2	.050	385	20	0	13	650	7.6	20.0	68	
29S/32E-35cac	325	7-18-79	72	.00	<.001	15	6.3	21	5.5	115	0	7.2	1.3	.4	.13	--	.04	.003	186	63	0	1.1	225	7.4	9.0	66	
29S/37E-17cca	190	8- 7-79	58	.05	.003	50	10	30	--	--	--	38	25	.2			.10	.003	--	--	--	--	492*	7.3	13.0	55	P.
32S/29E-14abc	228	7-23-79	71	.02	.002	28	10	26	6.7	122	0	35	15	.2	2.4	--	.07	.003	263	110	11	1.1	335	7.8*	14.0	57	
32S/32E-2adc	78	7-19-79	71	.08	.008	14	6.7	51	4.0	134	0	31	15	.8	1.0	--	.11	.006	264	63	0	2.8	337*	6.9	12.5	55	
32S/34E-36bcc	490	8- 8-79	48	.00	<001	12	8.3	6.3	2.0	76	0	7.2	2.0	.1	1.3	--	.01	.001	129	64	2	.3	160	8.0	13.5	56	
32S/36E-29daas	Spring	8- 7-79	58	.05	.001	<1	<1	100	--	--	--	30	15	.3			1	.26	--				817*	9.7*	18.5	65	P.
32½S/33E-29aab	110	7-21-79	19	.11	.01	4.9	1.2	2.2	.4	20	0	2.2	.4	.1	.06	--	.007	.003	40	17	1	.2	43*	7.4*	5.0	41	
33S/35E-13bdcs	Spring	1972	200	.02	<.02	.9	.1	550	35	774	11	230	240	16	--	.74	10.5	.01	1,690	--	--	--	2,490	8.1	73.0	163	G. Mickey Hot Spring.

See footnote at end of table.

Table 4.--Chemical analyses of water from wells and springs--Continued

Location no.	Depth of well (feet)	Date of collection	Milligrams per liter: Silica (SiO_2)	Iron (Fe)	Manganese (Mn)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO_3)	Carbonate (CO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrite (NO_2) + nitrate (NO_3) as N	Phosphorus, ortho as P	Boron (B)	Arsenic (As)	Dissolved solids, calculated from determined constituents	Hardness (Ca, Mg)	Noncarbonate hardness	Sodium-adsorption-ratio (SAR)	Specific conductance (micromhos/cm at 25°C)	pH	Temperature (°C)	Temperature (°F)	Remarks
34S/31E-3cab	685	7-23-79	77	0.00	0.61	25	10	61	6.0	244	0	18	7.3	0.6	0.01	--	0.08	0.003	326	100	0	2.6	480	6.7	16.0	61	
34S/31E-18ddc	--	8- 9-79	8.5	.001	.00	57	26	52	20	365	0	56	15	.3	.72	--	.44	.017	419	250	0	1.4	738*	7.4	11.5	53	
34S/34E-32dbas	Spring	1972	120	0.12	.02	13	2.2	960	69	1,196	1	220	780	10.2	--	0.43	30.0	.04	2,800	--	--	--	4,590	6.7	76.0	169	G. Alvord Hot Spring.
35S/32E-10bdc	191	7-24-79	36	.00	.13	14	7.1	8.6	2.8	89	0	4.4	1.6	.1	.04	--	.02	.001	119	64	0	.5	175	6.2	14.0	57	
35S/33E-14abb	400	8-13-79	36	.00	<.001	23	13	20	1.6	171	0	8.9	2.3	.2	.80	--	.02	.001	193	110	0	.8	311*	7.7	14.0	57	
37S/32½E-7dads	Spring	7-26-79	46	.1	.007	10	5	7	--	--	--	12	3.3	.2	--	--	<.005	.001	--	--	--	--	120	7.6*	13.0	55	P.
37S/32-3/4E-24cdas	do	8-14-79	46	.16	.02	34	14	59	1.0	280	--	22	9.2	.3	.12	--	.13	.01	325	140	0	2.2	479*	7.8	13.0	55	
37S/33E-11ccds	do	5-27-57	160	--	.10	9.6	--	426	29.0	425	--	328	265	6.5	--	1.4	15.0	1.0	1,520	--	--	--	2,190	7.5	87.0	189	G. Near Hot Borax Lake.
39S/33E-25bcas	do	8- 8-79	47	.08	.002	1.5	.4	29	2.1	70	0	5.0	2.1	.2	.25	--	.06	.003	123	5	0	5.4	130	8.2	22.0	72	
39S/37E-16s	do	1972	105	.08	<.02	18	.8	270	10.8	439	1	204	24	12.8	--	.06	.89	--	870	--	--	--	1,168	6.8	52.0	126	G. Near Trout Creek.
40S/36E-19ddd	59	8-11-79	54	.1	.005	30	10	50	--	--	--	52	23	.3	--	--	.10	.004	--	--	--	--	550	7.3	12.0	54	P.
41S/33E-2dba	50	8- 8-79	63	.03	.006	19	9.2	16	5.0	122	0	7.8	2.8	.2	.21	--	.04	.004	184	85	0	.8	230	6.8	12.0	54	
41S/35E-20acb	351	7-26-79	27	.00	<.001	65	19	29	5.6	171	0	130	22	1.3	1.6	--	.10	.001	390	240	100	.8	650	7.7	13.0	56	
41S/37E-1abds	Spring	8-14-79	8.8	.18	.003	5.4	1.9	5.7	4.0	29	0	11	2.5	.2	1.3	--	.02	.001	60	21	0	.5	83*	6.8	4.5	40	

* Laboratory determination.

Table 5.--Analyses of dissolved trace metals from selected water samples[1/]

[Estimated values in micrograms per liter]

Well or spring number	Aluminum (Al)	Antimony (Sb)	Barium (Ba)	Beryllium (Be)	Cadmium (Cd)	Chromium (Cr)	Cobalt (Co)	Copper (Cu)	Gallium (Ga)	Germanium (Ge)
23S/23E-27acb	70	< 30	< 7	< 1	1	< 50	< 5	< 10	< 30	< 30
26S/31E-33ccc	< 50	< 30	10	< 1	1	< 50	< 5	< 10	< 30	< 30
29S/37E-17cca	300	50	100	< 1	10	< 50	< 5	< 10	70	100
32S/36E-29daas	300	< 30	7	< 1	5	< 50	< 5	< 10	50	< 30
37S/32½E-7dads	300	< 30	10	< 1	< 1	< 50	< 5	< 10	< 30	30
40S/36E-19ddd	100	< 30	30	< 1	10	< 50	< 5	< 10	< 30	100

Well or spring number	Lithium (Li)	Molybdenum (Mo)	Nickel (Ni)	Silver (Ag)	Strontium (Sr)	Tin (Sn)	Titanium (Ti)	Vanadium (V)	Zinc (Zn)	Zirconium (Zr)
23S/23E-27acb	30	< 10	< 50	< 10	70	< 50	< 5	< 10	--	< 5
26S/31E-33ccc	70	10	< 50	< 10	10	< 50	< 5	< 10	5	< 5
29S/37E-17cca	10	< 10	< 50	< 10	300	300	5	30	50	< 5
32S/36E-29daas	10	10	< 50	< 10	7	70	7	< 10	< 5	< 5
37S/32½E-7dads	< 10	< 10	< 50	< 10	70	< 50	7	10	70	< 5
40S/36E-19ddd	10	< 10	< 50	< 10	100	100	< 5	30	10	< 5

1/ These analyses were made using a direct-reading emission-spectrometric procedure utilizing an induction-coupled argon plasma excitation source. The results are considered to be semiquantitative, accurate only to one significant figure, and to have a confidence level of 68 percent. Where values are reported as < some numerical value, that number represents the lowest level of detection for that metal. For instance, "< 50" given for chromium indicates dissolved chromium in the water sample was less than the detection level of 50 ug/L.

Table 6.—Source and significance of chemical and physical characteristics of water

Constituent	Potential source(s)	Significance or definition
Silica (SiO_2)	Silicate minerals in rocks.	Forms hard scale in high-pressure boilers.
Iron (Fe)	Iron-bearing minerals, well casings, and pipes.	In concentrations greater than 0.3 mg/L, may stain laundry and porcelain plumbing fixtures (National Academy of Sciences, 1974). Larger concentrations may impart objectionable taste to water.
Manganese (Mn)	Manganese-bearing minerals, decomposition of plant tissue.	In concentrations greater than 0.05 mg/L may cause brown to black stain in laundry and porcelain plumbing fixtures (National Academy of Sciences, 1974). Generally has same objectionable features as iron.
Calcium (Ca)	Rocks, soils, and "hardpan" deposits rich in calcium carbonate minerals and from fertilizers.	A constituent of scale deposits in water pipes, boilers, and cookware. Principal cause of water hardness.
Magnesium (Mg)	Ferromagnesium minerals in rocks.	A constituent of scale deposits in water pipes, boilers, and cookware. Second principal cause of water hardness.
Sodium (Na)	Sodium-bearing minerals in rocks; industrial wastes	Large concentrations in combination with chloride give water salty taste. Large concentrations in irrigation water may reduce soil permeability.
Potassium (K)	Potassium-bearing minerals in rocks; present in plant tissue, sewage, industrial wastes, and fertilizers.	Essential plant nutrient.
Bicarbonate (HCO_3) and carbonate (CO_3)	Carbon dioxide in air and soil atmosphere, "hardpan" deposits, or cementing material in sediments; also decomposition of organic matter in soil.	In combination with calcium and magnesium, cause carbonate hardness. Carbonates of calcium and magnesium form scale in steam boilers and hot-water facilities and release corrosive carbon dioxide gas.
Sulfate (SO_4)	Sulfide minerals in rocks, gypsum, precipitation, fertilizers, and sewage.	Sulfates of calcium and magnesium form hard scale. In concentrations greater than about 250 mg/L may have unpleasant taste and be cathartic to some individuals (National Academy of Sciences, 1974).
Chloride (Cl)	Soils and rocks, evaporite minerals, precipitation, animal wastes, and sewage.	Makes water corrosive; more than 250 mg/L may impart salty taste to water (National Academy of Sciences, 1974).
Fluoride (F)	Fluoride-bearing minerals which occur in trace amounts in most rocks.	Optimum concentrations tend to reduce decay of children's teeth; larger concentrations cause mottling of enamel of teeth. Concentration of fluoride in drinking water should not exceed 2 mg/L (U.S. Environmental Protection Agency, 1975).
Nitrate (NO_3) as N	Bacterial action in soil and plants; concentrated in plant and animal wastes, sewage, and fertilizers.	Essential plant nutrient. In surface water excessive nitrate and phosphates in combination cause algal blooms which may result in organic enrichment of water and depletion of dissolved oxygen. Consumption of water with more than about 10 mg/L of nitrate as N may cause methemoglobanemia in infants (U.S. Environmental Protection Agency, 1975). In excess of average concentrations may indicate pollution by organic wastes.
Phosphorus (P or phosphate (PO_4)	Phosphorus-bearing minerals present in most rocks in trace amounts. Component of sewage, animal wastes, fertilizers, and some detergents.	Essential plant nutrient. See nitrate.
Boron (B)	Boron-bearing minerals, volcanic gases, thermal springs, and sewage.	Essential in trace amounts to plant nutrition. In concentrations greater than about 2 mg/L, may be toxic even to tolerant crops (National Academy of Sciences, 1974).
Arsenic (As)	Dissolved from arsenic-bearing minerals. Ingredient of many herbicides and insecticides.	Prolonged consumption of water containing more than about 0.05 mg/L of arsenic may lead to chronic poisoning (U.S. Environmental Protection Agency, 1975).
Dissolved solids (residue on evaporation or calculated)		Measure of the concentration of dissolved solids in water.
Specific conductance		Indicator of the ability of a solute to conduct an electrical current. Gives indication of the concentration of dissolved solids in water.
Hardness as ($CaCO_3$)	Mainly dissolved calcium and magnesium in water.	Property of water related to the formation of an insoluble curd with soap and the formation of scale in pipes, boilers, and cooking utensils.
pH (hydrogen ion activity)	Hydrogen ions in solution.	Hydrogen ion activity expressed in negative logarithmic units. A measure of the dissociation of water molecules. A neutral solution has a pH of 7.0.
Temperature	Determined by local environment.	Important physical characteristic that affects taste, efficiency of waste-treatment processes, cooling, suitability of habitat for aquatic life, and suitability for irrigation.
SAR (sodium-adsorption-ratio)	Calculated from the following equation: $SAR = \frac{(Na^+)}{\sqrt{\frac{(Ca^{+2}) + (Mg^{+2})}{2}}}$ where: Na^{+2}, Ca^{+2}, Mg^{+2} are in milliequivalents per liter.	Equation predicts the degree to which irrigation water tends to enter into cation-exchange reactions in soil. High SAR values imply a hazard of sodium replacing adsorbed calcium and magnesium; this replacement is damaging to soil structure.

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GEOLOGICAL SURVEY

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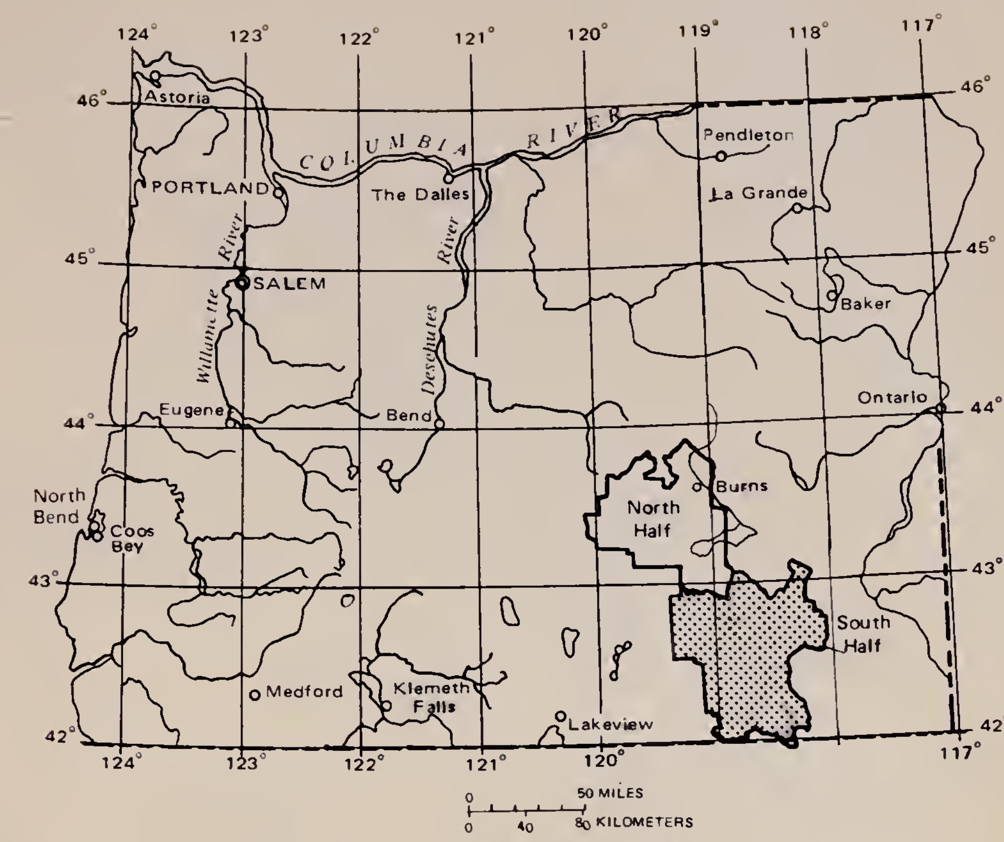


INDEX MAP OF OREGON

EXPLANATION

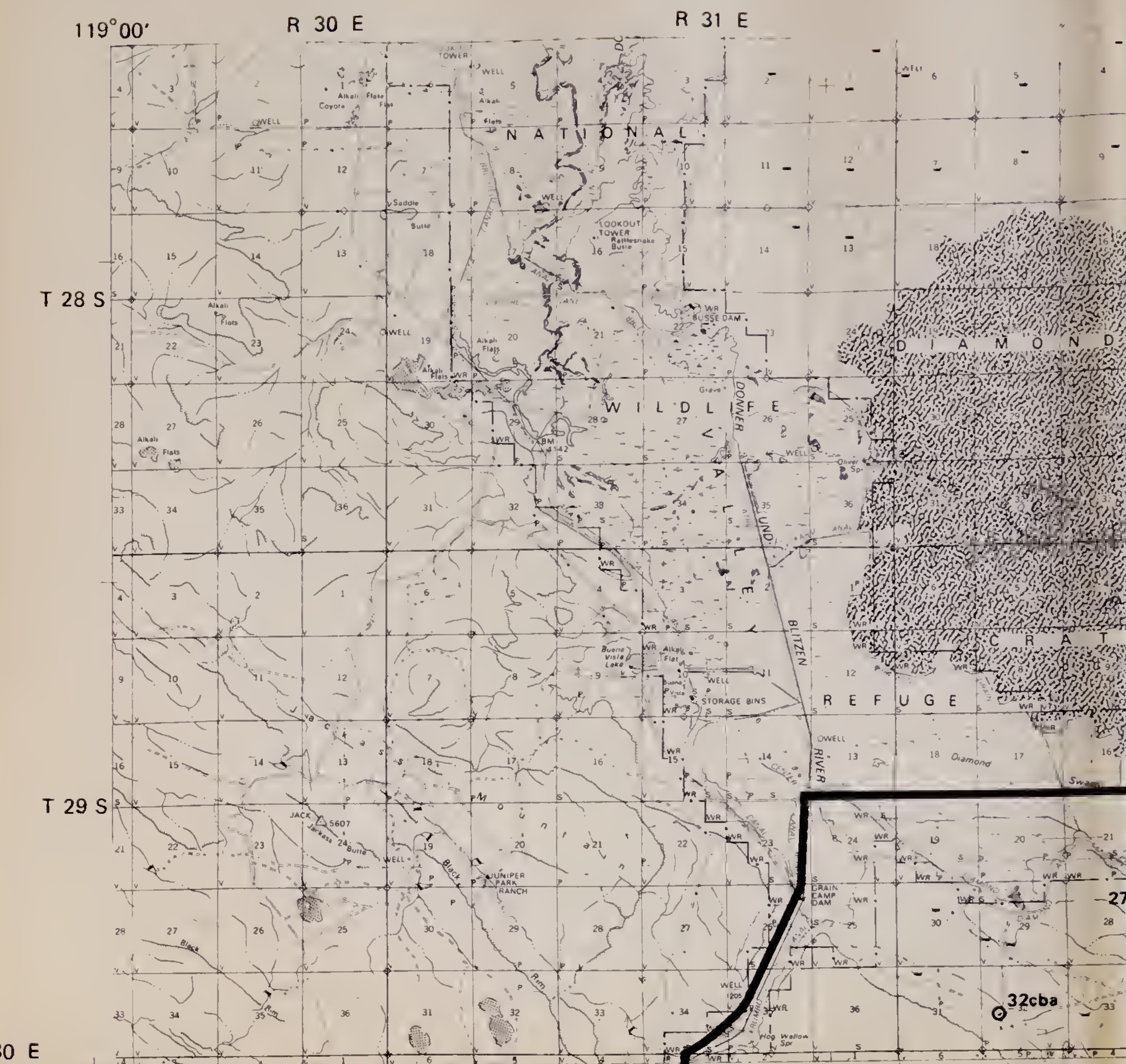
22dda ○ WELL – Location number shown. (See text for explanation)

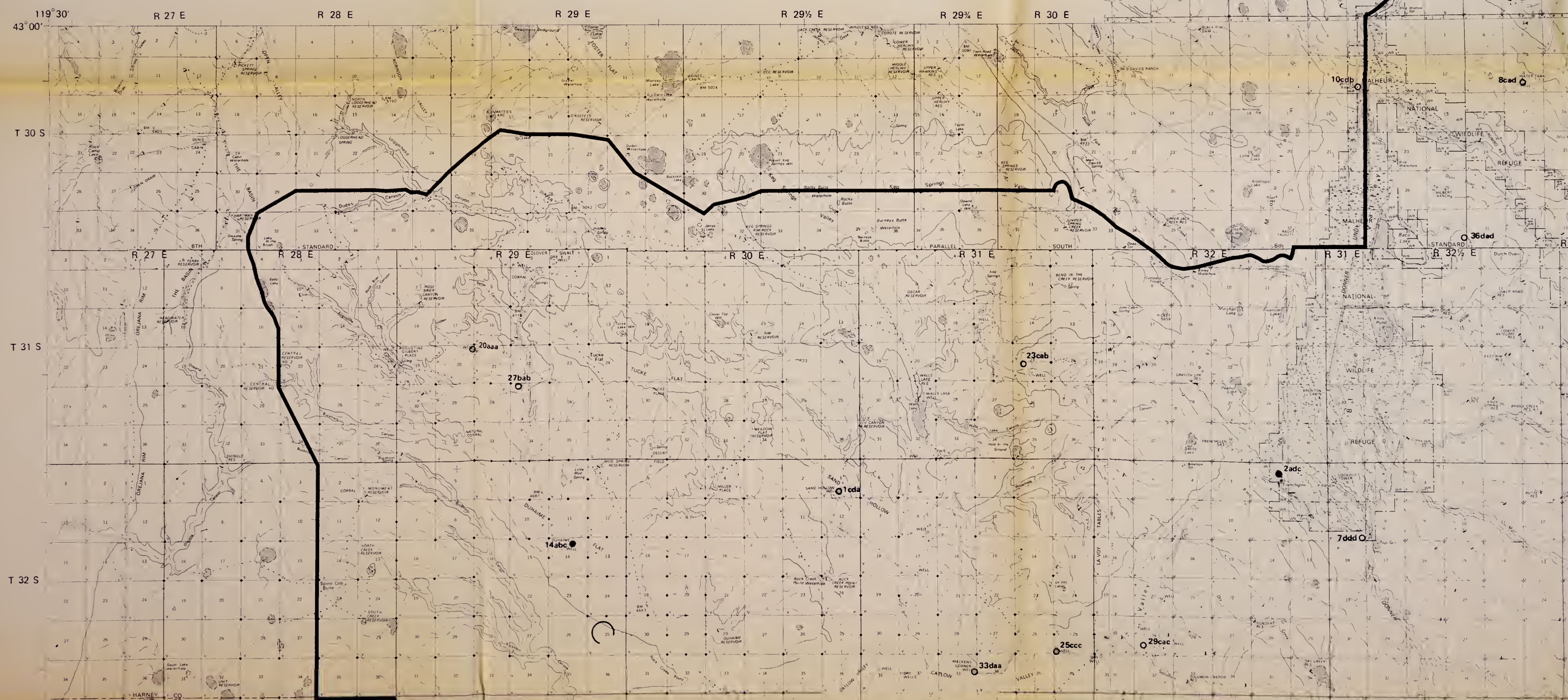
27ddc ● WELL – Chemical analysis in table 4.

29aab ◎ Observation well.

1dcbs SPRING – Location number shown. (See text for explanation)

13bcds SPRING – Chemical analysis in table 4.





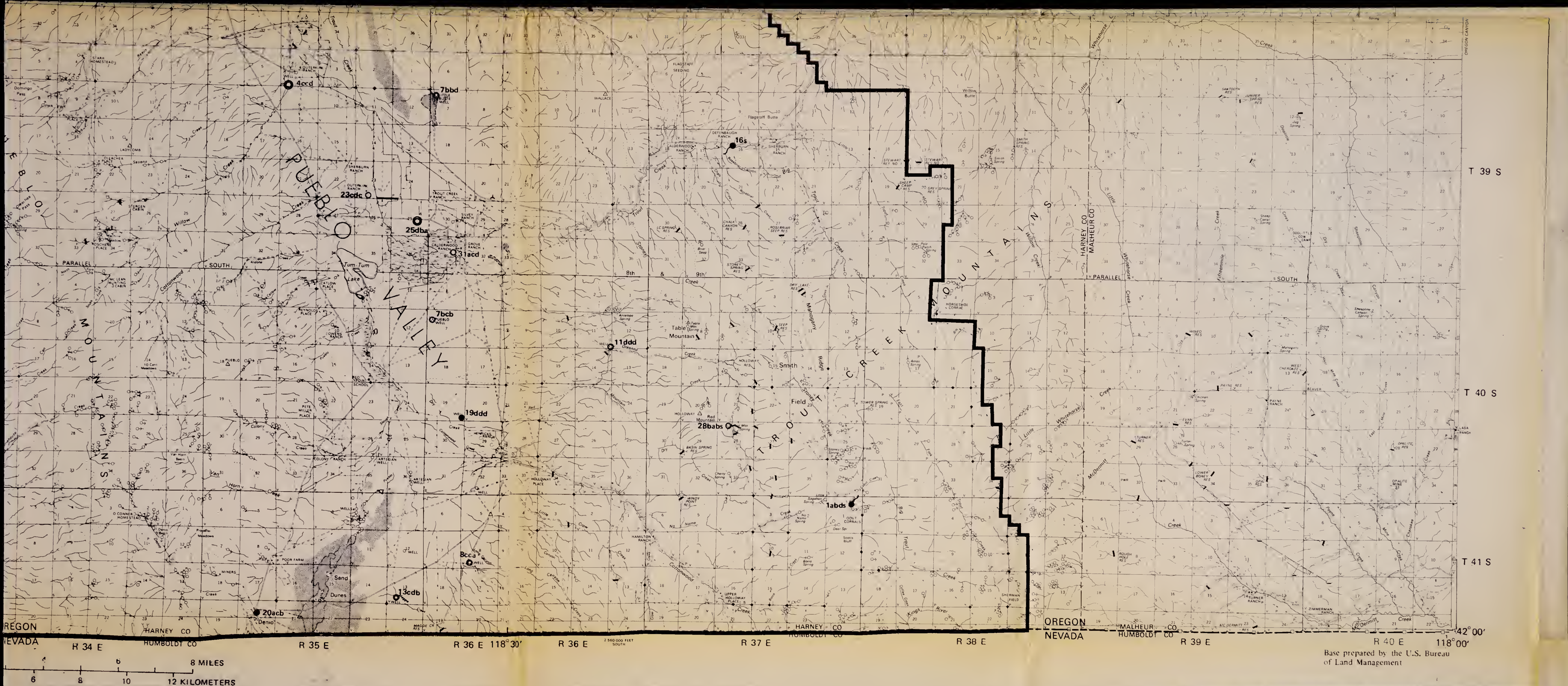
OOPERATION WITH THE
EAU OF LAND MANAGEMENT

OPEN-FILE REPORT 80-419
PLATE 1 (SOUTH HALF)

T 33 S
T 34 S
T 35 S
T 36 S
T 37 S
T 38 S
HART MOUNTAIN NATIONAL ANTELOPE REFUGE
LAKE CO
HARNEY CO
CATLOW VALLEY
7th STANDARD PARALLEL SOUTH
2cab
13dbb
31ddc
3cab
9dab
18ddc
23caa
21ccb
33daa
10bdc
23bad
32ddc
23bcb
12aca
4aaa
17daa
29bab
R 32 E
R 32½ E
R 33 E
Sand Dunes

T 32½ S
29daas
36bcc
35ddd
11cbb
8dcb
13bdcs
24aab
24bbc
20bba
27cca
3acc
10bcd
10dcd
15bca
27bdc
32dbas
14abb
14aab
23bad
34dcd
3aba
10aaa
16caa
16dcb
16ddc
7aacs
9acb
11bccds
22aac
24cdas
31bad
24bbd
Fields
Andrews
T 33 S
T 34 S
T 35 S
T 36 S
T 37 S
T 38 S
ALVORD VALLEY
ALVORD DESERT
ALVORD LAKE
STEENS MOUNTAIN
HARNEY CO
MALHEUR CO
STANDARD
PARALLEL
SOUTH
Sand Dunes
Dry Lake
Ancient Lake Shore
White Horse Butte
R 32¾ E
R 33 E
R 34 E
R 35 E
R 36 E
R 37 E
R 38 E
R 39 E

WELL AND SPRING LOCATIONS IN THE RILEY AN



ANDREWS RESOURCE AREAS, SOUTHEASTERN OREGON

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Table 6.—Source and significance of chemical and physical characteristics of water

Constituent	Potential source(s)	Significance or definition
Silica (SiO_2)	Silicate minerals in rocks.	Forms hard scale in high-pressure boilers.
Iron (Fe)	Iron-bearing minerals, well casings, and pipes.	In concentrations greater than 0.3 mg/L, may stain laundry and porcelain plumbing fixtures (National Academy of Sciences, 1974). Larger concentrations may impart objectionable taste to water.
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Calcium (Ca)	Rocks, soils, and "hardpan" deposits rich in calcium carbonate minerals and from fertilizers.	A constituent of scale deposits in water pipes, boilers, and cookware. Principal cause of water hardness.
Magnesium (Mg)	Ferromagnesium minerals in rocks.	A constituent of scale deposits in water pipes, boilers, and cookware. Second principal cause of water hardness.
Sodium (Na)	Sodium-bearing minerals in rocks; industrial wastes	Large concentrations in combination with chloride give water salty taste. Large concentrations in irrigation water may reduce soil permeability.
Potassium (K)	Potassium-bearing minerals in rocks; present in plant tissue, sewage, industrial wastes, and fertilizers.	Essential plant nutrient.
Bicarbonate (HCO_3) and carbonate (CO_3)	Carbon dioxide in air and soil atmosphere, "hardpan" deposits, or cementing material in sediments; also decomposition of organic matter in soil.	In combination with calcium and magnesium, cause carbonate hardness. Carbonates of calcium and magnesium form scale in steam boilers and hot-water facilities and release corrosive carbon dioxide gas.
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Phosphorus (P or phosphate (PO_4))	Phosphorus-bearing minerals present in most rocks in trace amounts. Component of sewage, animal wastes, fertilizers, and some detergents.	Essential plant nutrient. See nitrate.
Boron (B)	Boron-bearing minerals, volcanic gases, thermal springs, and sewage.	Essential in trace amounts to plant nutrition. In concentrations greater than about 2 mg/L, may be toxic even to tolerant crops (National Academy of Sciences, 1974).
Arsenic (As)	Dissolved from arsenic-bearing minerals. Ingredient of many herbicides and insecticides.	Prolonged consumption of water containing more than about 0.05 mg/L of arsenic may lead to chronic poisoning (U.S. Environmental Protection Agency, 1975).
Dissolved solids (residue on evaporation or calculated)		Measure of the concentration of dissolved solids in water.
Specific conductance		Indicator of the ability of a solute to conduct an electrical current. Gives indication of the concentration of dissolved solids in water.
Hardness as ($CaCO_3$)	Mainly dissolved calcium and magnesium in water.	Property of water related to the formation of an insoluble curd with soap and the formation of scale in pipes, boilers, and cooking utensils.
pH (hydrogen ion activity)	Hydrogen ions in solution.	Hydrogen ion activity expressed in negative logarithmic units. A measure of the dissociation of water molecules. A neutral solution has a pH of 7.0.
Temperature	Determined by local environment.	Important physical characteristic that affects taste, efficiency of waste-treatment processes, cooling, suitability of habitat for aquatic life, and suitability for irrigation.
SAR (sodium-adsorption-ratio)	Calculated from the following equation: $SAR = \frac{(Na^{+})}{\sqrt{\frac{(Ca^{+2}) + (Mg^{+2})}{2}}}$ where: Na^{+2}, Ca^{+2}, Mg^{+2} are in milliequivalents per liter.	Equation predicts the degree to which irrigation water tends to enter into cation-exchange reactions in soil. High SAR values imply a hazard of sodium replacing adsorbed calcium and magnesium; this replacement is damaging to soil structure.

UNITED STATES DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

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EXPLANATION

22dda ○ WELL Location number shown. (See text for explanation)

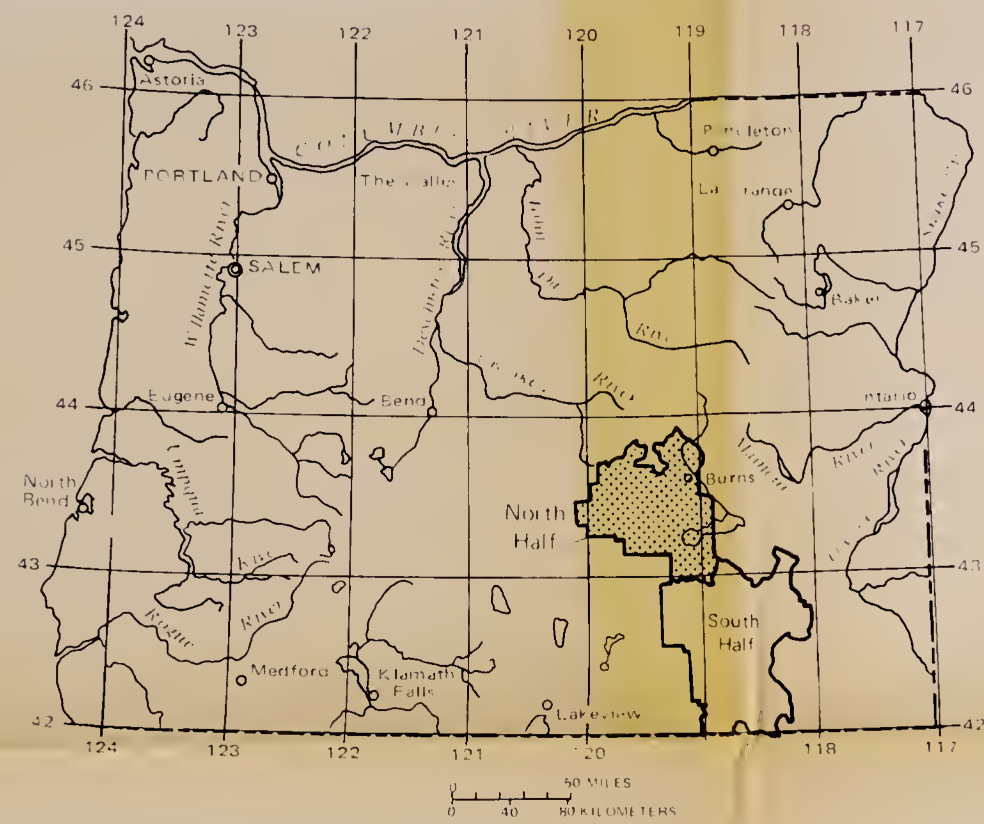
27ddc ● WELL Chemical analysis in table 4.

29aab ◎ Observation well.

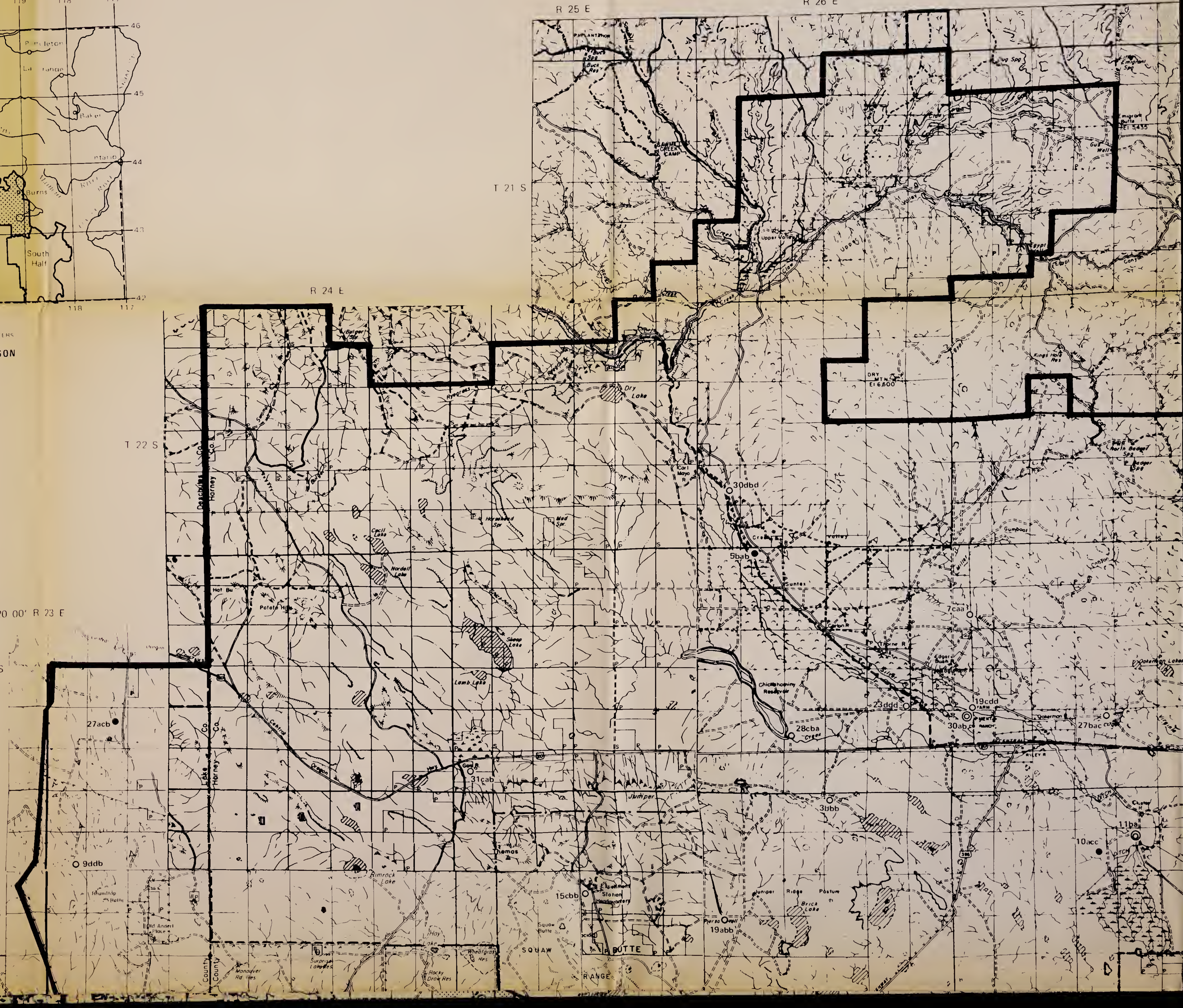
1dcbs SPRING Location number shown. (See text for explanation)

13bcds SPRING Chemical analysis in table 4.

Area covered by State Ground Water Report 16.



INDEX MAP OF OREGON



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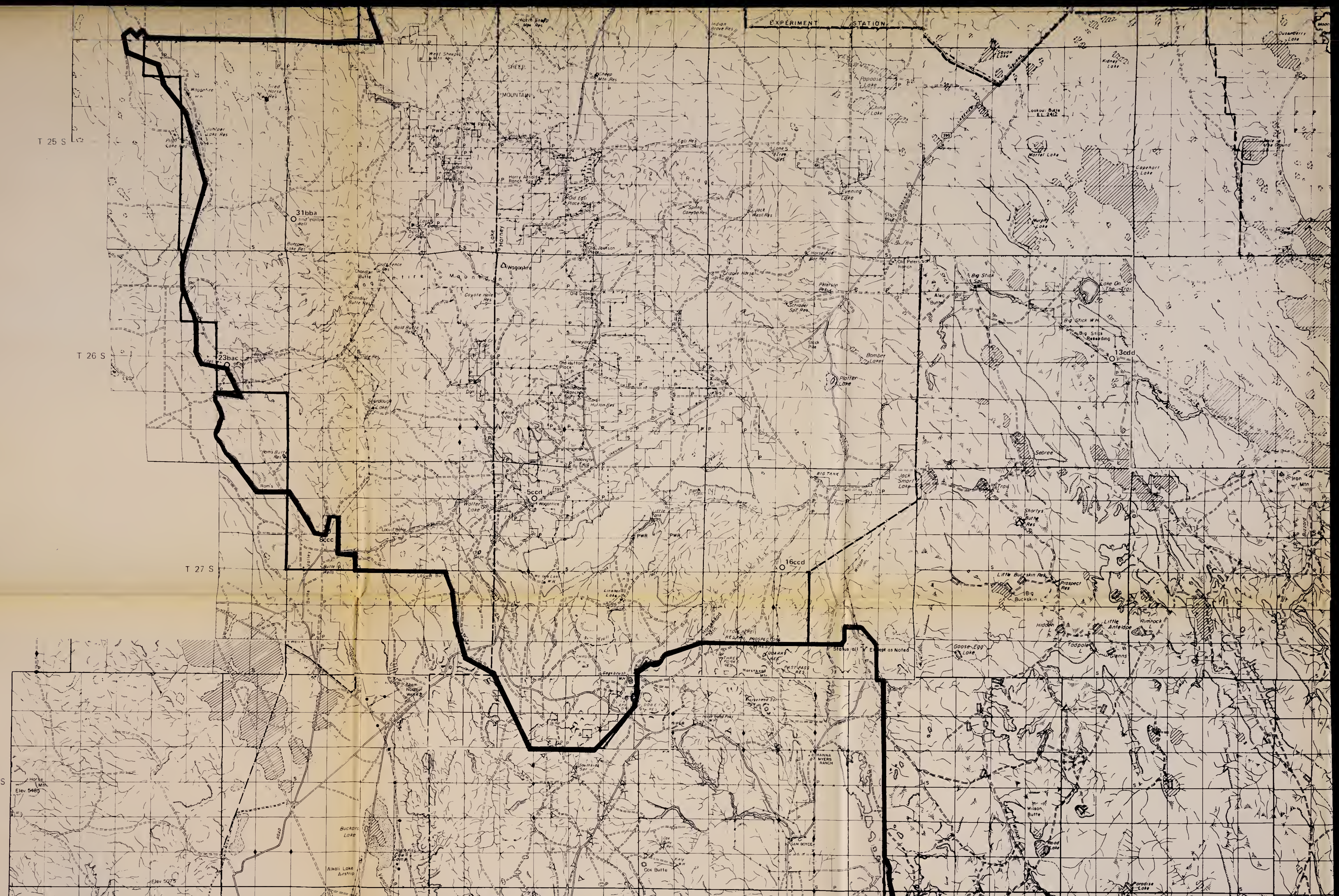
OPEN-FILE REPORT 80-419
PLATE 1 (NORTH HALF)



EXPERIMENT STATION
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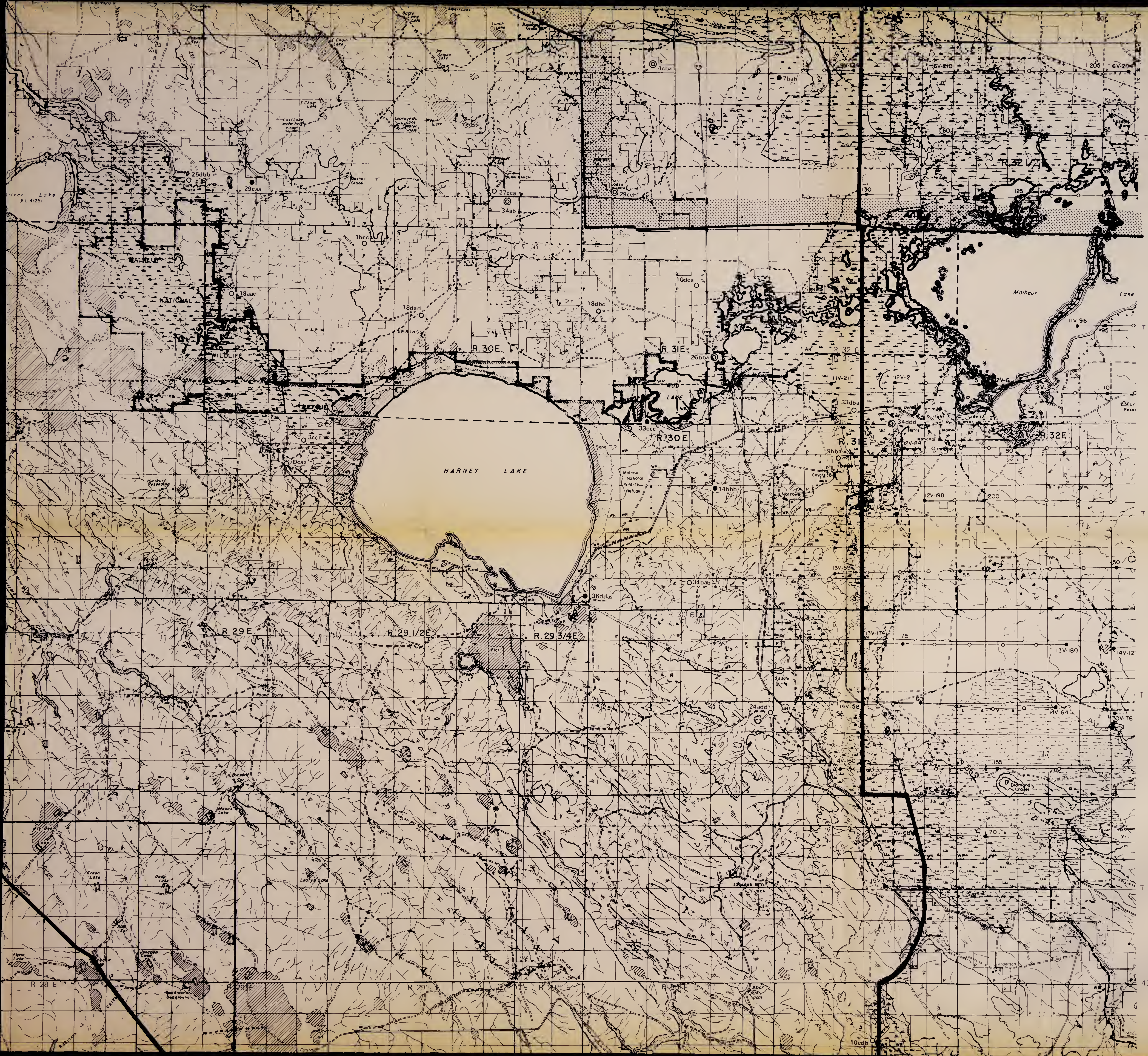
31bba
23bac
5ccd
8ccc
16ccd
13cdd
COUNTY



HARNEY LAKE
Malheur Lake
MALHEUR
NATIONAL
WILDLIFE
REFUGE
R. 28 E.
R. 29 E.
R. 29 1/2 E.
R. 29 3/4 E.
R. 30 E.
R. 31 E.
R. 32 E.
T. 25 S.
T. 26 S.
T. 27 S.
T. 28 S.
T. 29 S.
43°00'
25dbb
29caa
27cca
34ab
29ccb
4cba
7bab
1bcc
18aac
18dad
18dbc
10dca
26bba
33ccc
33dba
34ddd
3ccc
9bba
14bbb
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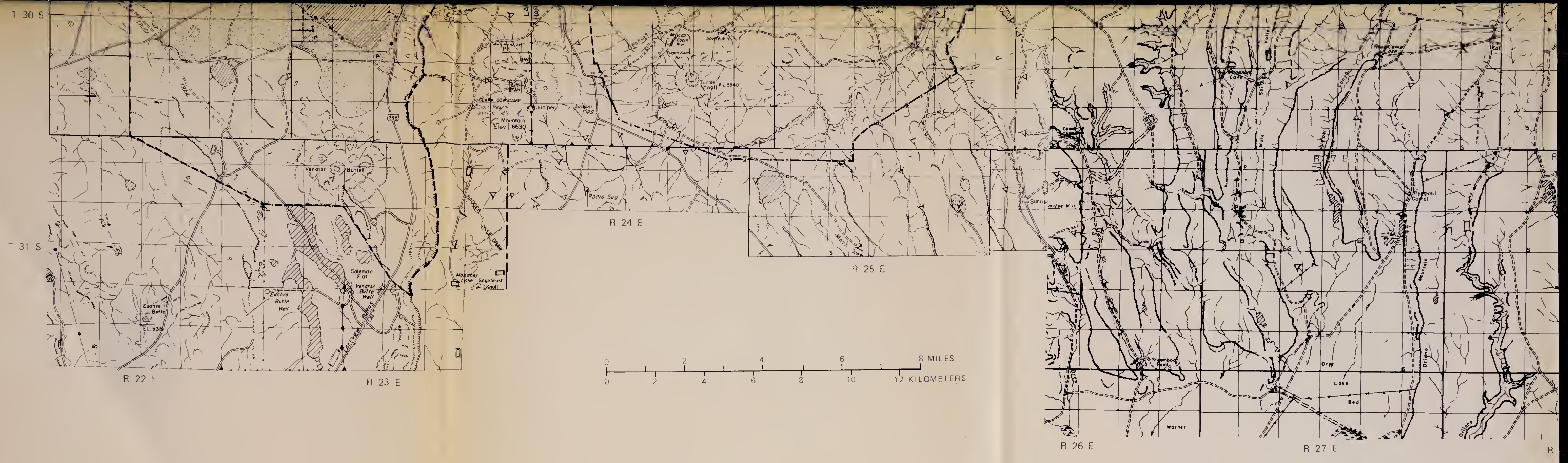
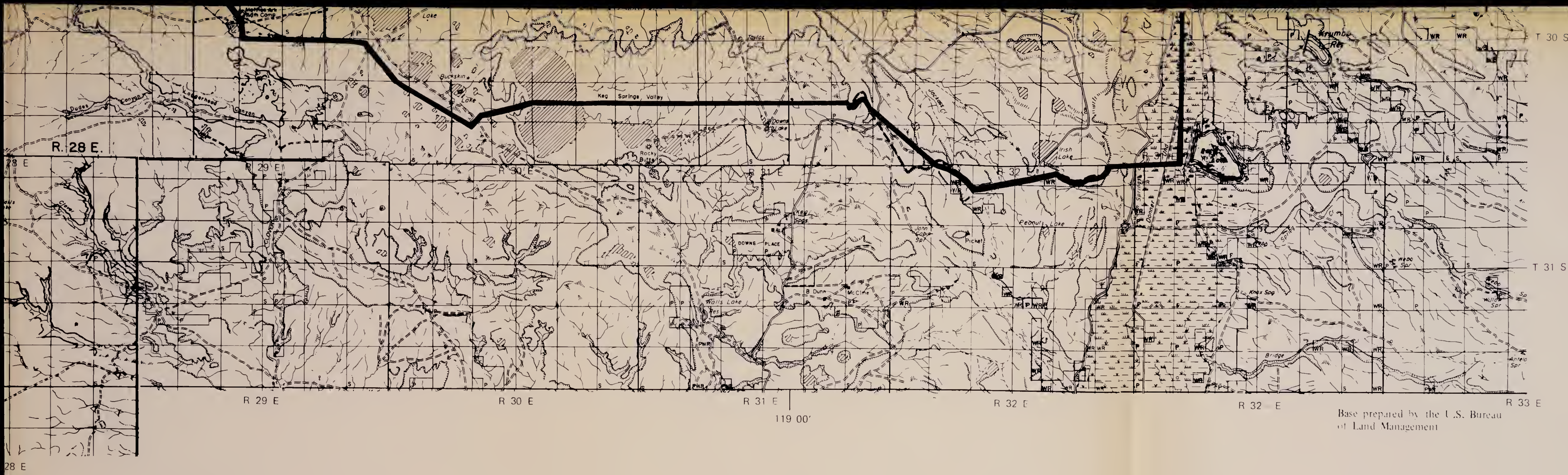
36dda
24ddd
10cdb



WELL AND SPRING LOCATIONS IN THE RILEY AND A

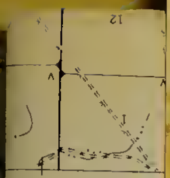


Base prepared by the U.S. Bureau of Land Management

NDREWS RESOURCE AREAS, SOUTHEASTERN OREGON

Table 6.—Source and significance of chemical and physical characteristics of water

Constituent	Potential source(s)	Significance or definition
Silica (SiO_2)	Silicate minerals in rocks.	Forms hard scale in high-pressure boilers.
Iron (Fe)	Iron-bearing minerals, well casings, and pipes.	In concentrations greater than 0.3 mg/L, may stain laundry and porcelain plumbing fixtures (National Academy of Sciences, 1974). Larger concentrations may impart objectionable taste to water.
Manganese (Mn)	Manganese-bearing minerals, decomposition of plant tissue.	In concentrations greater than 0.05 mg/L may cause brown to black stain in laundry and porcelain plumbing fixtures (National Academy of Sciences, 1974). Generally has same objectionable features as iron.
Calcium (Ca)	Rocks, soils, and "hardpan" deposits rich in calcium carbonate minerals and from fertilizers.	A constituent of scale deposits in water pipes, boilers, and cookware. Principal cause of water hardness.
Magnesium (Mg)	Ferromagnesium minerals in rocks.	A constituent of scale deposits in water pipes, boilers, and cookware. Second principal cause of water hardness.
Sodium (Na)	Sodium-bearing minerals in rocks; industrial wastes	Large concentrations in combination with chloride give water salty taste. Large concentrations in irrigation water may reduce soil permeability.
Potassium (K)	Potassium-bearing minerals in rocks; present in plant tissue, sewage, industrial wastes, and fertilizers.	Essential plant nutrient.
Bicarbonate (HCO_3) and carbonate (CO_3)	Carbon dioxide in air and soil atmosphere, "hardpan" deposits, or cementing material in sediments; also decomposition of organic matter in soil.	In combination with calcium and magnesium, cause carbonate hardness. Carbonates of calcium and magnesium form scale in steam boilers and hot-water facilities and release corrosive carbon dioxide gas.
Sulfate (SO_4)	Sulfide minerals in rocks, gypsum, precipitation, fertilizers, and sewage.	Sulfates of calcium and magnesium form hard scale. In concentrations greater than about 250 mg/L may have unpleasant taste and be cathartic to some individuals (National Academy of Sciences, 1974).
Chloride (Cl)	Soils and rocks, evaporite minerals, precipitation, animal wastes, and sewage.	Makes water corrosive; more than 250 mg/L may impart salty taste to water (National Academy of Sciences, 1974).
Fluoride (F)	Fluoride-bearing minerals which occur in trace amounts in most rocks.	Optimum concentrations tend to reduce decay of children's teeth; larger concentrations cause mottling of enamel of teeth. Concentration of fluoride in drinking water should not exceed 2 mg/L (U.S. Environmental Protection Agency, 1975).
Nitrate (NO_3) as N	Bacterial action in soil and plants; concentrated in plant and animal wastes, sewage, and fertilizers.	Essential plant nutrient. In surface water excessive nitrate and phosphates in combination cause algal blooms which may result in organic enrichment of water and depletion of dissolved oxygen. Consumption of water with more than about 10 mg/L of nitrate as N may cause methemoglobanemia in infants (U.S. Environmental Protection Agency, 1975). In excess of average concentrations may indicate pollution by organic wastes.
Phosphorus (P or phosphate (PO_4)	Phosphorus-bearing minerals present in most rocks in trace amounts. Component of sewage, animal wastes, fertilizers, and some detergents.	Essential plant nutrient. See nitrate.
Boron (B)	Boron-bearing minerals, volcanic gases, thermal springs, and sewage.	Essential in trace amounts to plant nutrition. In concentrations greater than about 2 mg/L, may be toxic even to tolerant crops (National Academy of Sciences, 1974).
Arsenic (As)	Dissolved from arsenic-bearing minerals. Ingredient of many herbicides and insecticides.	Prolonged consumption of water containing more than about 0.05 mg/L of arsenic may lead to chronic poisoning (U.S. Environmental Protection Agency, 1975).
Dissolved solids (residue on evaporation or calculated)		Measure of the concentration of dissolved solids in water.
Specific conductance		Indicator of the ability of a solute to conduct an electrical current. Gives indication of the concentration of dissolved solids in water.
Hardness as ($CaCO_3$)	Mainly dissolved calcium and magnesium in water.	Property of water related to the formation of an insoluble curd with soap and the formation of scale in pipes, boilers, and cooking utensils.
pH (hydrogen ion activity)	Hydrogen ions in solution.	Hydrogen ion activity expressed in negative logarithmic units. A measure of the dissociation of water molecules. A neutral solution has a pH of 7.0.
Temperature	Determined by local environment.	Important physical characteristic that affects taste, efficiency of waste-treatment processes, cooling, suitability of habitat for aquatic life, and suitability for irrigation.
SAR (sodium-adsorption-ratio)	Calculated from the following equation: $SAR = \dfrac{(Na^{+})}{\sqrt{\dfrac{(Ca^{+2}) + (Mg^{+2})}{2}}}$ where: Na^{+2}, Ca^{+2}, Mg^{+2} are in milliequivalents per liter.	Equation predicts the degree to which irrigation water tends to enter into cation-exchange reactions in soil. High SAR values imply a hazard of sodium replacing adsorbed calcium and magnesium; this replacement is damaging to soil structure.



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